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AN INVESTIGATION OF THE CONSTRUCTION OF THE VARIOUS KINDS OF CUPOLAS THAT HAVE BEEN USED FOR THE MELTING OF PIG-IRON.

BY M. A. GOUVY, JR.*

Translated by W. F. Durfee, Engineer.

The translator, regarding the paper of M. Gouvy as of great value to all manufacturers of iron and steel, inasmuch as it presents, in one comprehensive view, most of the experiments that have been tried in many lands, with a hope of improving the working of cupolas, offers to English readers the substance of it, in the belief that, if its conclusions are intelligently followed by users of cupolas, very large economies will result; for his own investigations,

* Étude sur les cubilots pour la fusion de la fonte. Par M. A. Gouvy Fils," published in "Mémoires et compte rendu des travaux de la Société des Ingénieurs Civils." Paris, 1887. pp. 723–766.

many years ago, led to the conclusion that the most of the cupolas then in use in this country, wasted three-quarters of the fuel put into them, and that there were but very few, indeed, that utilized one-half; conclusions which observation in recent years has furnished no reason to change.—W. F. D.

PURPOSE OF THE PAPER.

It is intended in this paper to glance cursorily over the successive improvements which have been made in the construction of cupolas for the fusion of pig-iron, since their use has become general in metallurgy, and to give some information relative to certain special methods of construction which have been invented, based upon principles more or less understood, and to describe a few of the more recent forms of apparatus which have attracted the most attention from metallurgical engineers. In these pages, therefore, will be found a description of the most important inventions relating to the cupola, as well as an account of the results obtained in most of the cases, together with a discussion of the value of the most important of the systems described.

I.

FIRST APPARATUS USED FOR THE FUSION OF PIG-IRON.

The first melting of pig-iron was accomplished probably in crucibles, which were heated by coal in a furnace in which the consumption of fuel was very great.

In order to avoid this inconvenience, those who first made castings from pig-iron had recourse to an apparatus similar to a cupola, called a "Calabash," which was fired either with coal or coke.

Valerius speaks of "calabashes" at Brussels* using coke, which consumed 77 to 88 pounds of coke for every 220 pounds of castings made, without counting the coal used for heating the "calabash," or the coke wasted.

The "calabashes" at Charleroi consumed 81·5 to 95 pounds of coke for each 220 pounds of iron melted, besides 2·7 to 3 per cent of coal; the waste of iron was not more than 5 to 6 per cent., as in ordinary cupolas.

* Valerius: "Traité de la fabrication de la fonte," 1851.

Reaumur describes the "portable calabashes," which we remember are still used in the country by the Gypsies for repairing saucepans.*

Among the more recent endeavors to augment the very small melting capacity of the "calabashes" we find the cupola, originally invented by Wilkinson (1790) and called a "shaft furnace," or "cupola."

The first stationary furnaces were provided with "shafts" or "cupolas" of masonry at their tops, from which the gas escaped, and it is probable that from this construction we derive the name ("cupola") in common use at the present time.

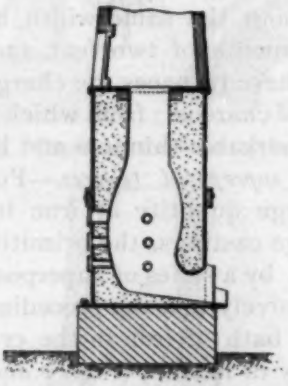


FIG. 1. Cupola with Rammed-up Walls.

These cupolas were of very primitive construction, having but a single tuyere, and their shafts either rectangular, oval or circular, in cross section, their walls being formed of refractory sand rammed into a casing of cast iron, a construction which required frequent repairs. Their height was not often more than five or eight feet. Charcoal was used as a fuel, and the quantity consumed was exceedingly great, often, in fact, amounting to fifty per cent. of the very small production of the furnace.

A cupola of this kind is represented by *Fig. 1*.

*The making of castings from iron melted in crucibles and in "calabashes" is illustrated and described in Emanuel Swedenborg's "De Ferro," published in 1734. W. F. D.

A cupola was built at Seraing (about 1850) having rammed walls, which were repaired once in eight days, and entirely renewed every six weeks; the crucible or bottom being repaired three times per week. The product per hour was about one ton of castings, with a total consumption of coke in the neighborhood of twenty per cent. We must here observe, that, notwithstanding the improvement in the cupolas used in foundries at the present time, it is rare good luck if, in economy of coke, they attain or surpass the above figure.

In China, where industrial progress for a long time has been almost nothing, they use small furnaces eight feet in height, with about the same width, having an internal diameter of the crucible of two feet, and provided with a single tuyere.* These furnaces are charged with a mixture of ore, cast iron and charcoal; from which are produced cooking utensils of remarkable thinness and lightness.

Cupolas having superposed tuyeres.—For the purpose of accumulating a large quantity of iron in the crucible for the making of large castings, the primitive system of fixed tuyeres is replaced by a series of superposed tuyeres, which are opened successively, and the preceding tuyeres stopped, as the level of the bath of iron in the crucible rises. The cupola of a foundry in Berlin† (*Figs. 2 and 3*) is of this construction. The system was for a long time employed in France, and perhaps is still in vogue in some foundries (*Fig. 4*).

II.

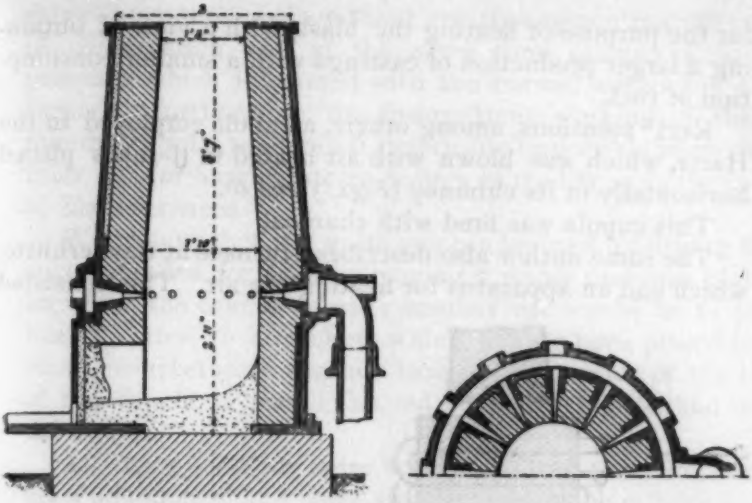
THE EMPLOYMENT OF HOT BLAST AND THE UTILIZATION OF THE GAS ESCAPING FROM THE TOP OF THE FURNACE.

Since the employment of cupolas in foundries has become general, a great number of patents for improvements have successively been issued.

A modification which was at first considered as of great importance, but afterwards gradually abandoned, consisted in the utilization of the gas wasted at the top of the furnace,

* *Chemical News.*

† Bruno Kerl: *Handbuch der Metallurgischen Hüttenkunde, 1855.*



FIGS. 2, 3. Cupola of the Foundry in Berlin.

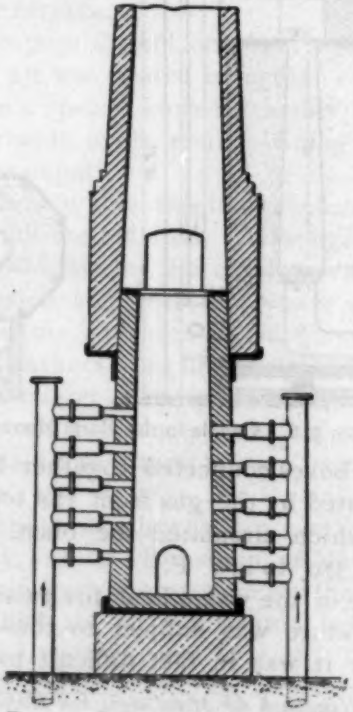


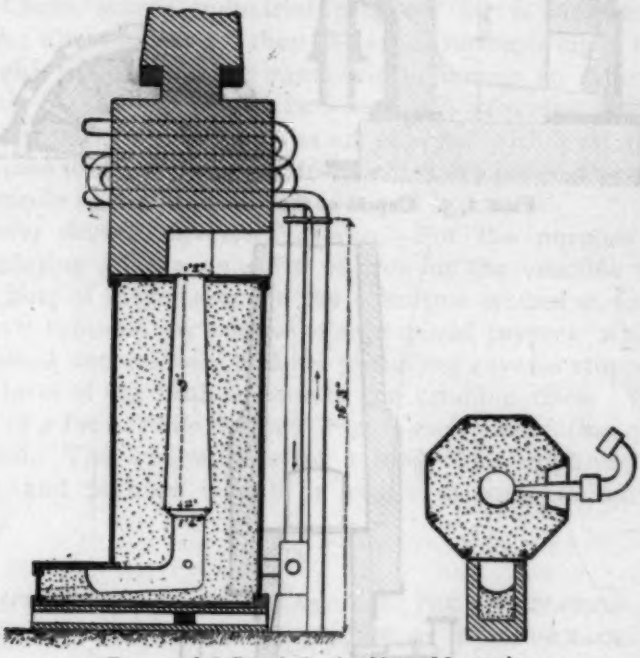
FIG. 4. Common French Cupola.

for the purpose of heating the blast, with a view of obtaining a larger production of castings with a smaller consumption of fuel.

Kerl* mentions, among others, a cupola employed in the Hartz, which was blown with air heated in U-tubes placed horizontally in its chimney (*Figs. 5 and 6*).

This cupola was fired with charcoal.

The same author also describes a furnace at Saynerhütte, which had an apparatus for heating the air. This consisted



FIGS. 5, 6. Cupola in the Hartz Mountains.

of two annular boxes connected together by vertical tubes, which were heated by the gas from the top of the furnace, and through which circulated the blast, which was thus heated to from 370° to 470° F.

Still, the use of the waste heat for raising the blast to a certain temperature was subject to the following inconveniences, viz: it was in fact difficult to place the appa-

* Bruno Kerl: *Handbuch der Metallurgischen Hüttenkunde, 1855.*

ratus above the cupola without greatly augmenting the cost of construction, and at the same time causing a back-pressure, which interfered with the normal working of the furnace; furthermore, the intermittent working of these foundry cupolas rendered it practically impossible to employ their gas for heating steam boilers as readily as in the case of blast furnaces.

We believe that the waste gas can be used for drying the coke intended for fuel, by passing it under cast-iron plates on which the coke is spread; another use would be to pre-heat the iron to be melted, which, having been placed in a small reverberatory furnace located on one side of the top of the cupola, is heated to a red heat and then pushed into the cupola.

All these methods were so complicated that they have been abandoned, and more simple arrangements have been sought for heating the blast without using the heat lost at the top of the furnace.

For this purpose Cabrol obtained a patent for a system by which the air was heated by actual contact with incandescent coal in a special closed chamber, thus charging the blast with carbonic oxide, and obtaining a very high temperature in the cupola.

Wright & Brown pass the blast, before it enters the furnace, around the melted iron. Although Kerl asserts that in Silesia they obtain by the employment of heated air a more rapid fusion, and with less waste of iron, it appears that these systems have not as yet given the results predicted by their authors; but have been successively rejected, either for the reason that their construction was too complicated, or from the absence of real advantages.

Nevertheless, these attempts have been continued in the same direction, and in 1871 Sir R. Mallet mentioned the Summerson cupola, which was blown with heated air.

The Ronchain Cupola.—Ronchain, of Maubeuge, patented, in 1885, a cupola having a passage for the blast within the masonry, in which the air was heated before it entered the cupola by the upper tuyeres (*Fig.* 7). The lower tuyeres were opened at variable heights according to the quantity

of iron in the crucible, in order to avoid exposing it to the action of the cold air.

Ronchain reports a consumption of twenty-two pounds of coke for the fusion of 220 pounds of iron, and about thirty pounds consumed before charging the iron.

The Woolwich Cupola.—At Woolwich there was a cupola that had a wind-box whose dimensions may be called enormous, as it extended from the tap-hole of the furnace

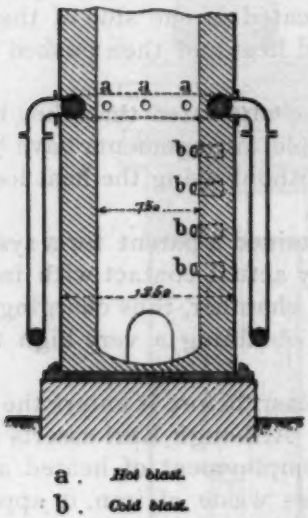


FIG. 7. The Ronchain Cupola.

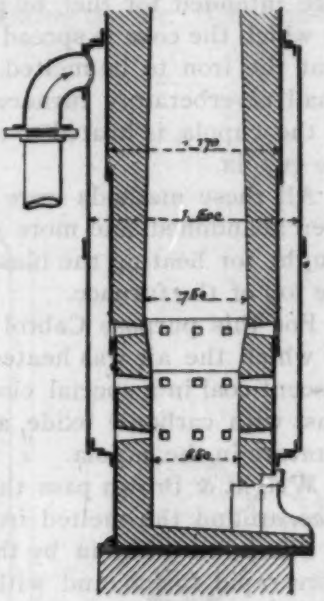


FIG. 8. The Woolwich Cupola.

almost to its top (*Fig. 8*). It had three rows of tuyeres, spaced one foot apart vertically.

We find also in Armengaud's publication* the description of a cupola having a wind-box (*Fig. 9*) communicating directly with the interior of the furnace by orifices which take the place of tuyeres. Such an annular box intended for heating the air is also employed by Voisin.

Tittl and Erndt's System.—Quite recently (in 1885) a detached crucible applied to a cupola, according to the

* Armengaud: *Publication Industrielle.* Vol. 22, p. 185.

system of M. Krigar, has been patented in Bohemia by MM. Tittl and Erndt.* In this system the blast traverses the tubes placed above the detached crucible, which are heated by the flame that passes out of the cupola through the lower orifice, and also by the radiation from the bath of melted iron (*Fig. 10*).

The Sheffield Cupola.—An arrangement which appears more practical than those already mentioned is described in "The Engineer"† as being employed in the Steel Works of Brown, Bayley & Dixon, at Sheffield.

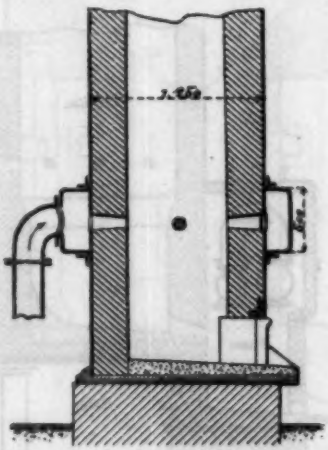


FIG. 9. Cupola with an Annular Wind-Box.

In this apparatus the blast pipes are connected to a series of sixteen U-tubes sixteen feet in height, having 1,700 square feet of heating surface; these are placed in two chambers located at the top of the chimney of a Bessemer Converter; the waste heat from the converter passes into these chambers, thus heating the blast intended for the cupolas, which are thirty-seven feet in height, and have two rows of tuyeres, placed one foot apart; the diameter at the tuyeres is four feet, and at the crucible five feet.

* *Dingler's Polytechnisches Journal*, 1885. Vol. 258, p. 445.

† *The Engineer*, 1879, p. 321.

The temperature of the blast is from 360° to 445° F., and we are told that the consumption of coke (for melting probably) is not more than 6·6 to 7 pounds per 100 pounds of iron melted.

Finally, we conclude that the employment of heated air for blowing cupolas, only results in an increase of their melting power in consequence of the elevation of the temperature of the zone of fusion; but we do not find any economy of fuel, which fact is attributable to the zone of fusion extending to a very much greater height than when

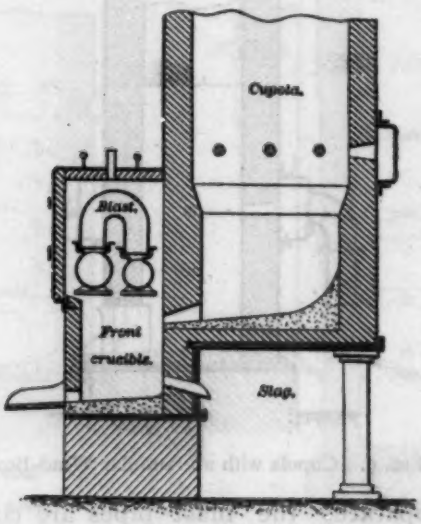
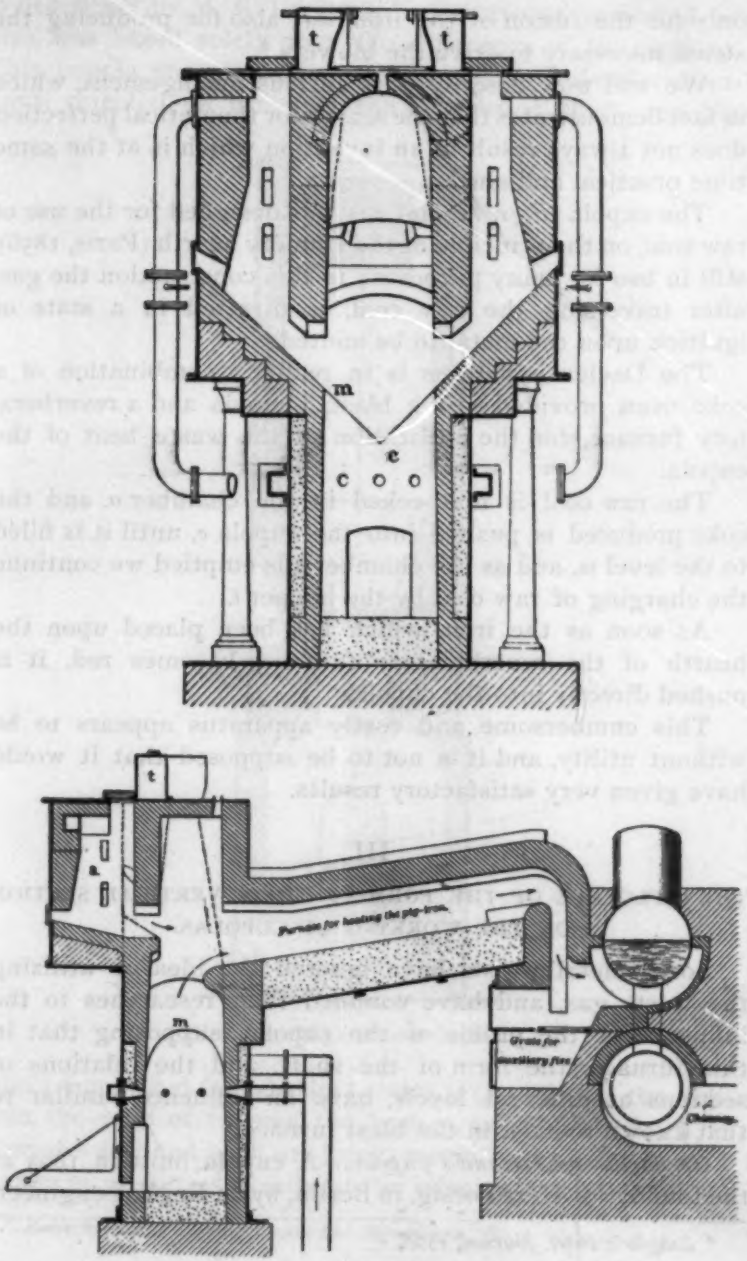


FIG. 10. The Tittl and Erndt, or Modified Krigar System.

cold air is used, and therefore the carbonic acid formed at the tuyeres encounters a very large surface of incandescent coke, which effects a reduction of this gas, and the advantages of heating the blast are annihilated by the loss of heat due to the transformation of this carbonic acid into carbonic oxide.

The Daelen Cupola.—Notwithstanding all the experiments that have been made without decisive results, M. A. Daelen recommends a very complicated German construction, which proposes to utilize the waste heat of the cupola, not



FIGS. 11, 12. The Daelen Cupola. (Scale 1-48.)

only for the fusion of the iron, but also for producing the steam necessary to drive the blowers.*

We will now describe this curious arrangement, which in fact demonstrates that the search for theoretical perfection does not always result in an invention which is at the same time practical and simple.

The cupola (*Figs. 11* and *12*) was designed for the use of raw coal, on the principle of the Duméry hearth (Paris, 1856), still in use for many purposes; in this construction the gas, after traversing the raw coal, is directed in a state of ignition upon the metal to be melted.

The Daelen apparatus is in reality a combination of a coke oven provided with a blast, a cupola and a reverberatory furnace, for the utilization of the waste heat of the cupola.

The raw coal is first coked in the chamber *a*, and the coke produced is pushed into the cupola *c*, until it is filled to the level *m*, and as the chamber *a* is emptied we continue the charging of raw coal by the hopper *t*.

As soon as the iron, which has been placed upon the hearth of the reverberatory furnace, becomes red, it is pushed directly into the cupola.

This cumbersome and costly apparatus appears to be without utility, and it is not to be supposed that it would have given very satisfactory results.

III.

THE INFLUENCE OF THE FORM OF THEIR VERTICAL SECTION ON THE WORKING OF CUPOLAS.

Some metallurgists have ignored the idea of utilizing the waste gas, and have confined their researches to the influence of the profile of the cupola; supposing that in this furnace, the form of the shaft, and the relations of sections at different levels, have an influence similar to that known to exist in the blast furnace.

Gerhardi and Ireland's Cupola.—A cupola built in 1863 at the foundry of Herr Borsig, in Berlin, by an English engineer,

* *Dingler's Polyt. Journal, 1866.*

is described by M. R. Gerhardi,* after it was perfected by him, was based solely upon the difference of its sections. This cupola was not, in fact, different from Ireland's. Gerhardi rejected, on principle, the cylindrical shaft, and his

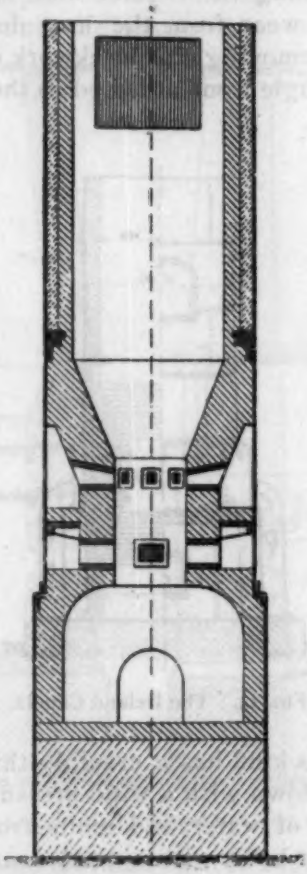


FIG. 13. The Gerhardi Cupola.

cupola comprised four distinct zones (*Fig. 13*), viz: the crucible, the zone of tuyeres, the boshes, and the shaft. The interior was lined with fire-brick, carefully shaped to avoid change of profile, especially in the vicinity of the tuyeres, of

* *Zeitschrift des Vereins Deutscher Ingenieure, 1869.* Vol. 13, p. 273.

which there was twelve arranged in two levels, the four lower tuyeres having a section twenty-five square inches (five inches square), and the eight upper tuyeres seven square inches (2·64) each. In order to repair with ease those parts adjoining the tuyeres and boshes (which are exposed to great wear, from the heat developed at these points), without removing the brickwork of the shaft, it is supported upon angle irons attached to the iron shell enveloping it.

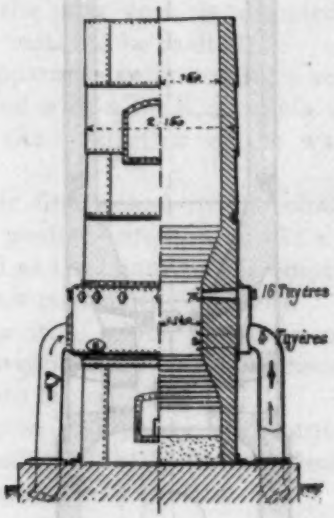
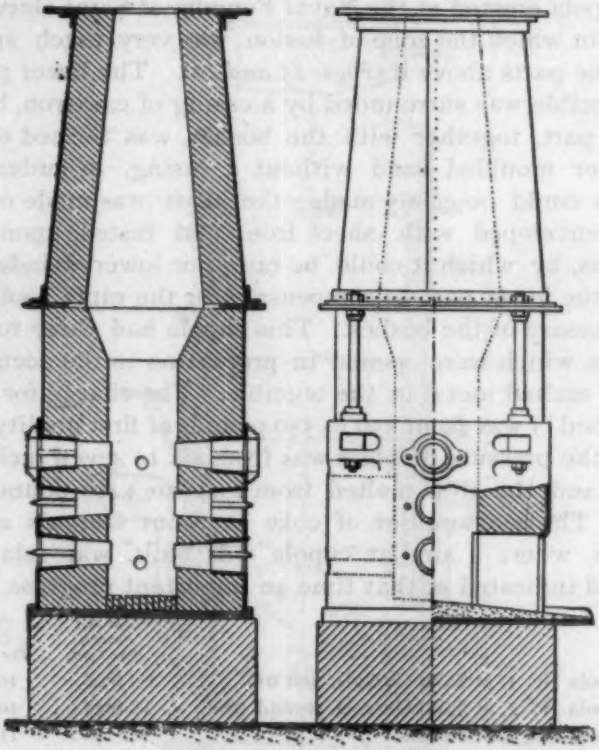


FIG. 14. The Ireland Cupola.

A cupola of this kind has a crucible thirty-six inches in diameter, and is blown with a wind pressure of from fifteen to sixteen inches of water, and melts from 4,959 to 5,730 pounds of iron per hour, with a total consumption of 13·5 per cent. of coke. A saving is made in the fuel required for "the bed" by not filling the furnace to the boshes, but only to the narrow part at the top of the crucible, the regular charge of 551 pounds of iron and fifty-five pounds of coke being immediately added. The blast is not turned on to the small tuyeres (the upper row) until the liquid iron is seen through the lower tuyeres.

The advantage presented by the narrowing at the tuyeres is, that we obtain by this construction a reduction of the volume of the charge, and ensure its regular descent at this point.

As the principal part of the combustion is concentrated at the smallest section, the temperature developed in front



FIGS. 15, 16. Cupola of the Naval Foundry of St. Gervais.

of the tuyeres is more elevated than in cupolas that are cylindrical throughout their whole height. The enlargement of the crucible is intended to collect a very large quantity of fluid iron at one time, in case it is required for the casting of large pieces.

Fig. 14 represents a cupola built by M. Ireland, at Bolton, in England, for the casting of an anvil block weighing 210 tons, and it has a section nearly identical with that of the

cupola just described, but its two rows of tuyeres are different in dimensions and number.

The first cupola built by M. Ireland had but two tuyeres, but in his later constructions he adopted sixteen and twenty tuyeres arranged in two rows.

Cupolas of St. Gervais and Nevers.—We will also speak of the cupola erected at the Naval Foundry at Saint Gervais in 1856,* in which the zone of fusion was very much smaller than the parts above it (*Figs. 15 and 16*). The lower part of the crucible was surrounded by a casing of cast iron, but its upper part, together with the boshes, was formed of firebrick or moulded sand without a casing, in order that repairs could be easily made; the shaft was made of firebrick enveloped with sheet iron, and rested upon four columns, by which it could be raised or lowered independent of the lower part, to compensate for the rapid cooling of the masonry of the boshes. This cupola had three rows of tuyeres, which were opened in proportion to the accumulation of melted metal in the crucible. The charge for lighting ("bed") was from 330 to 550 pounds of first quality hard coke; the pressure of blast was from six to seven inches of water, and the iron melted from 2,645 to 3,406 pounds per hour. The consumption of coke at Saint Gervais and at Nevers, where a similar cupola was built, was relatively low and indicated at that time an important progress.

	Coke for Fusion. Per Cent.	*Total Coke. Per Cent.*
Cupola No. 1, at Saint Gervais, first trial, . . .	6·08	10·29
Cupola No. 1, at Saint Gervais, second trial, . .	6·45	10·32
Cupola No. 1, at Nevers, ...	?	11·28

The loss of iron was not four cent.

The same system applied to a cupola of very small dimensions mounted on wheels (portable furnace) gave a consumption of coke of 13·48 per cent.

Cooling of the walls.—In order to preserve the walls of the cupolas above the tuyeres from wear, a current of water is employed in a manner similar to its use for that purpose in blast furnaces.

* *Industrie Minérale*, 1858–59. Vol. 4, p. 59.

Cupola at Troy.—A cupola provided with a circulation of water around its boshes, built at the Albany and Renssalaer Iron and Steel Works, at Troy, N. Y., for the melting of Bessemer iron, and which is remarkable besides for its dimensions, is represented by *Fig. 17.* This cupola* is charged with a mixture of sixty-five per cent. of hard anthracite, and

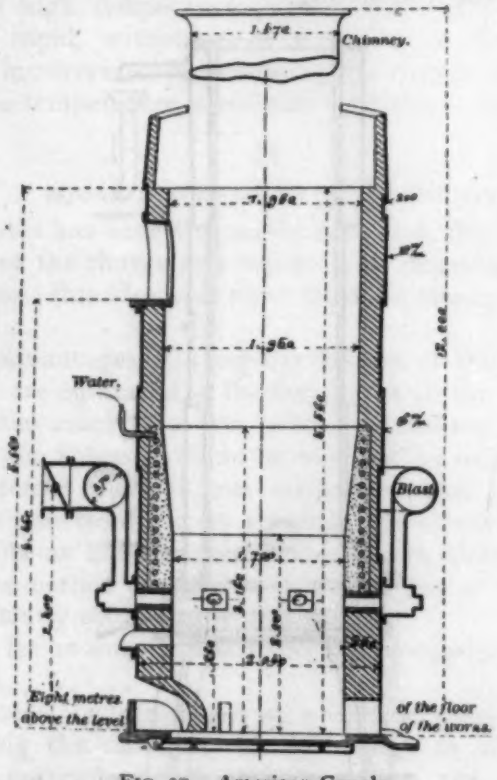


FIG. 17. American Cupola.

thirty-five per cent. of coke, and is provided with eight tuyeres, 5 x 8 inches. Except the boshes (which are rammed up of refractory material) the cupola is cylindrical; it melts at the rate of ten tons per hour.

The Gmelin Cupola.—Cooling has also been employed in cupolas whose sections are perfectly cylindrical; the cupola

* *Engineering*, 1880. Vol. 30, p. 592.

invented by M. O. Gmelin, of Budapest, and erected in the works of Ganz & Co. (manufacturers of cast-iron car wheels), is constructed with a double envelope of plate iron, in which the cold water circulates; there is no brickwork used except for the crucible; but a refractory plaster, one to two inches in thickness, is spread over the whole of the interior of the iron plating.

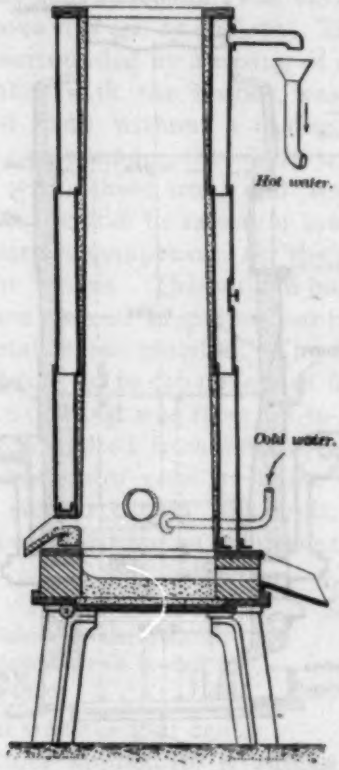


FIG. 18. The Gmelin Cupola.

When we consider that the heat given off to the water circulating in the hollow shell is at least fifteen per cent. of that developed in the furnace, and that this is about three times the heat which would be lost by radiation in case the shaft was constructed of masonry; it is evident that this design does not present an economy either in first cost, or

in maintenance. With such a cupola thirteen feet in height, and thirty-four inches in diameter, having an air pressure of from fourteen to sixteen inches of water, there can be melted from 10,000 to 11,000 pounds of metal per hour; the consumption of water being thirty-five gallons per minute. The advantages of this form of cupola are, the ability to secure a high temperature, obtain the iron hot, and the melting rapid, without fear of injury to the walls, and without inconveniently increasing the charge of limestone; lastly the temperature is constant at different heights.

IV.

EQUAL DISTRIBUTION OF THE BLAST.

The idea has been frequently advanced, that the regular descent of the charge in a cupola is an important condition of success; this idea is derived from the theory of the blast furnace.

The advantages of a regular descent of the material in a cupola are embraced in the facts, that all the coke is completely consumed; the iron melts at a uniform rate, and its composition is less liable to be modified by oxidizing gases, and therefore there is less waste of metal. In order to secure these results, it is necessary to obtain throughout the cupola as uniform distribution of the blast as possible. With the earlier constructions, having one or two tuyeres, this evidently could not be attained.

Now, let us consider the effect of two opposite tuyeres in a cupola.

The blast is introduced at a certain pressure, and, encountering the materials of the charge, is deflected into oblique currents, which reunite above the axis of the tuyeres; the combustion is active along the course of these currents, and the greatest heat is developed at *a*, where they unite, but at the same time at *b* the temperature is very low, which may be easily ascertained by introducing a bar of iron through the tuyeres *t*, *t*, and quickly withdrawing it.

Should we endeavor to obviate this inconvenience by disposing the axis of the tuyeres obliquely relative to the line *c d*, with a view of giving the blast a gyratory movement,

in which case the zone of combustion *a* is increased in diameter, but the low temperature at *b* still exists, or is somewhat increased by giving the axis of the tuyeres an inclination upward and downward, and by having a pressure

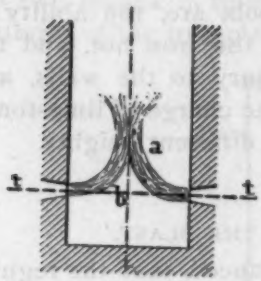


FIG. *a*.

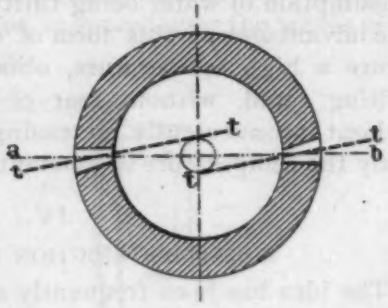
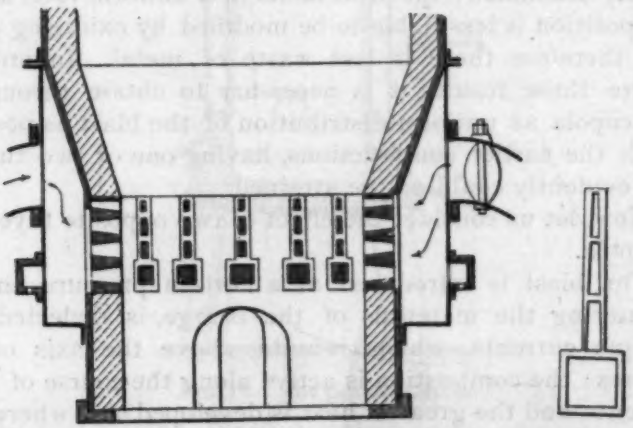


FIG. *b*.

of blast sufficient to overcome the resistance of the charge, which is only substituting this for the other inconveniences.

The Lawrence Tuyere.—An interesting arrangement, when considered with reference to the principle underlying it, is



FIGS. 19, 20. The Lawrence Tuyeres.

employed by M. Lawrence, of Philadelphia.* Immediately above the principal tuyeres, which are of rectangular section, there are three rows of orifices, each row being nar-

* *Polytechnic Review, 1877.*

rower than the one below it (*Figs. 19* and *20*); the jet of blast from the lower tuyeres is stronger, and is thrown farther into the interior of the cupola, than the jets superposed, which furnish the blast for that portion of the coke which lies near the walls of the shaft.

These tuyeres are placed around the circumference of the cupola at a distance of four inches from centre to centre.

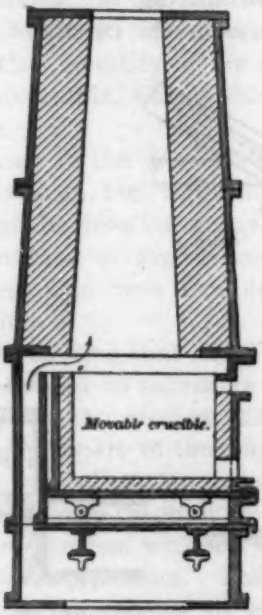


FIG. 21. The Bocard Cupola. Scale, 1-40.

The Bocard Cupola.—The best system that has been proposed for the purpose of ensuring an equal distribution of the blast, is that which introduces the air around the whole circumference of the cupola, by means of a continuous slit.

The *Genie Industriel* described, in 1858,* a cupola based upon this principle, which was invented by M. Bocard, of *Chatillon sur Seine* (*Fig. 21*). The level of the introduction of the blast in this system was necessarily fixed, and could not be vertically displaced. This cupola was pro-

* Armengaud: *Genie Industriel.* Juillet, 1858, p. 9.

vided with a crucible of large dimensions, mounted on wheels, which enabled it to be readily removed and replaced, and also allowed it to be used as a casting ladle. In a cupola of this construction, having a section of sixteen inches square, it is said that from 3,300 to 4,400 pounds of iron were melted per hour.

Some years later MacKenzie secured a patent for an arrangement for introducing the blast by an annular slit. Afterwards, in 1880, came the cupola of Fauler, of Freiburg

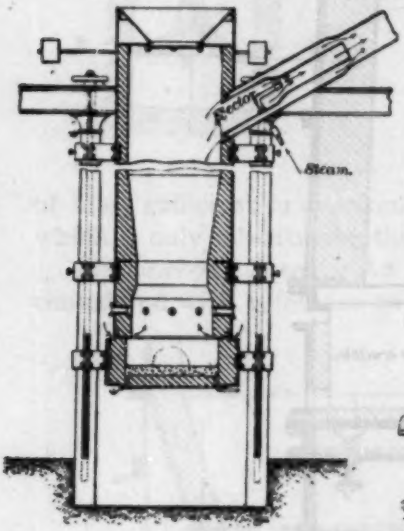


FIG. 23. The Herbertz Cupola.

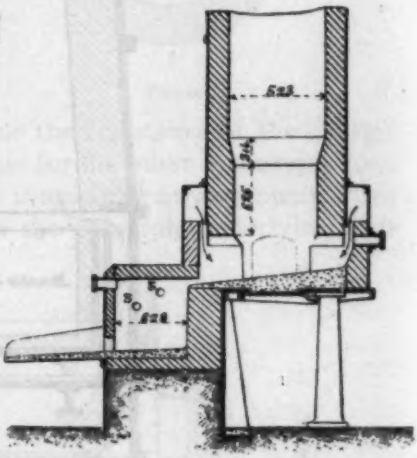


FIG. 26. The Common Krigar Cupola.

(Baden), in which a hollow ring of cast iron, having a slit, distributed the blast throughout the whole circumference of the cupola.

Still these arrangements did not allow, except with difficulty, the inspection and cleaning of the annular conduit of the blast in case of an overflow of slag, and these conduits wore out rapidly, and were often difficult to replace.

Krigar's Cupola.—The cupola constructed by M. Krigar, of Hanover, and which is employed in a large number of works in Germany, also ensures a regular distribution of the air by means of an annular box (*Fig. 26*) having vertical

rectangular orifices, which open immediately into the largest part of the crucible proper, and as the blast is compelled to rise in the charge by passing through the narrowed section directly above the orifices, they are never affected by the slag, and all the melted iron is collected in a separate crucible placed in front of the cupola.

The total consumption of coke in a cupola of this kind is from 10·4 to 15·7 per cent. of the iron charged. Nevertheless, this apparatus, like all the preceding, presents the inconvenience that the quantity of air blown in at a constant pressure is invariable, unless dampers are used to control its admission.

This is not the case in the *Herbertz* system, which also employs an annular tuyere, but which is capable of adjustment as the height of the iron varies, and at the same time by employing the method of aspiration, the lower part of the cupola is entirely free from trouble arising from the stoppage of the tuyeres.

However, notwithstanding that the Herbertz system of annular tuyere is intended to secure an equal distribution of the wind throughout the section, the employment of a jet of steam in the upper part of the cupola for creating a draft produces a contrary effect; in other words, the gas is made to traverse the charge through its largest interstices, and the greater part escapes without being utilized, thus producing an irregular combustion. The published analysis of the gas from this cupola shows an excessive amount of oxygen, which indicates the presence of large spaces in the charge.

(*To be continued.*)

FEASIBILITY OF UNDERGROUND RAILROADS IN PHILADELPHIA.

BY LEWIS M. HAUPT.

[*A Lecture delivered before the* FRANKLIN INSTITUTE, *Monday, November 5, 1888.*]

Prof. HAUPT was introduced by the Secretary of the INSTITUTE, and spoke as follows:

MEMBERS OF THE INSTITUTE, LADIES AND GENTLEMEN:

As in the physical world, there is "first the blade, then the ear, and then the full corn in the ear," so in the material world there is a gradual development extending over a longer or shorter period of time.

The philosophic poet, Shakespeare, divides the life of man into a number of distinct stages, and the observant philosopher will find corresponding phases in the materialization of every idea. But that an idea may germinate successfully and bear fruit, its time, place and conditions must be favorable. It must be in season. If ahead of or behind the times it will not mature; but the test can only be made by exposing the idea to the intelligence of the community. If ripe, it will be accepted; if not, it must lie fallow.

It will require no effort of the imagination to discern the several stages in the development of the subject suggested for this lecture.

In the evolution of a material project, the first stage is that of mental conception; the second, that of education and propagation; and the third, that of execution or fruition. The first step, concerns merely the one or more individuals who may have planned the project; the second, concerns the community, or those in whose behalf the works may have been designed. It is the crucial stage, as it involves the very existence of the plan. This question is then submitted to those interested. Will you or will you not accept this work, in its existing or in any modified form,

upon any given or required condition? This is the present phase of the rapid transit problem in this city. To answer it intelligently, it is necessary that the project shall be fairly presented to, and be understood by the community; that it may decide without bias, and with a view to promote the best interests of the municipality as a whole.

To aid in disseminating knowledge as to these important commercial, social and engineering problems, is one of the purposes of this course of lectures, given under the auspices of the FRANKLIN INSTITUTE, and hence I shall confine myself to-night to that part of the second stage, which treats of the physical possibilities and characteristics of the project, to give Philadelphia rapid transit by underground roads.

Your first interrogatory will naturally be, Is it practicable? In answering it, we must consider the requirements of the proposed way, and size of the rolling stock, to determine the proper dimensions; and then apply these to the topography of the site, with its numerous obstructions, to discover whether it is possible to construct such a conduit. The next step, will be one of cost and expediency; this has already been partially considered on a previous occasion. To be successful, and to relieve the surface of the frequent and dangerous grade crossings, it is necessary that the tunnels should be large enough to pass the existing rolling stock on the steam roads entering the city. This requires at least 15 feet in height and 10½ feet in width, for a train of maximum section, so that for a double-track tunnel, with allowance for clearance, the neat section must be about 17 x 25 feet. For pavement over the crown of the arch, about three feet would be required, thus bringing the grade of the tunnel twenty feet below that of the surface. We now have the two elements of width and depth necessary to provide a passage-way and, wherever these can be obtained on a continuous line, there the road could be constructed. It has been objected that this is but a small part of the problem, but it is the vital part, and, if this be possible, it cannot be said that the project is impracticable, however inexpedient it may seem.

To ascertain whether or not this continuous line may be obtained, it is also necessary to know the practical limits of the changes in direction (both vertically and horizontally) of modern rolling stock. For these data we may take the maximum resistances found on existing lines of railways; thus, on the P. W. and B. R. R. approach to the tunnel under Thirty-second Street, there is an ascent of 1·2 feet per hundred on a curve of 12°, or radius of only 478 feet, while the maximum limit of curvature on a level, for a road locomotive, with ordinary wheel base is 19°. On the Schuylkill Valley Division of the P. R. R., near West Laurel Hill, there are grades of 2·3 per cent. or 121·4 feet to the mile, and on the Reading R. R. there are grades of 2·5 per cent.

On the Manhattan Elevated R. R. of New York, the sharpest curves have a radius of only ninety feet.

We have just seen that the level of the underground roadway should be at least twenty feet below the surface. To ascend from that depth with a two per cent. grade, the ground being level, would therefore require a length of one thousand feet, and to rise still higher, so as to make an overhead crossing, with a minimum clearance of thirteen feet and three feet for superstructure, would take 800 feet more, or from underground to overhead a total of 1800 feet; the surface being level. Hence, it is freely asserted that it is impossible to connect the present surface terminals with an underground system. But it should be observed that this distance diminishes as the surface slopes increase, until it reaches zero, when the inclination is vertical—as at the face of a tunnel or retaining wall. By studying, therefore, the topographical features of the site, the physical possibility of the project may be determined.

At this time, when the subject of greater facilities is attracting so much attention, it becomes a matter of great importance to examine both sides of the discussion, that correct conclusions may be reached. This can best be done by taking the opinions of competent engineers who are opposed to underground roads, as being antagonistic to other projects which are believed by them to offer a more acceptable solution. If there are insuperable physical difficulties in

the way, there should be no better authorities to discover and proclaim them than these engineers.

Hence I assume that in devoting a short time to the consideration of these public objections, I will best reply to the doubts which may exist in the minds of those most interested in the subject.

The first objection, as stated, is to the effect that:

"Philadelphia, * * * south of Lehigh Avenue, is not topographically suited for an underground scheme. * * * The area of Philadelphia in question is nearly level (excepting at the rivers), and the subsoil, with its beds of clay and underlying quicksands is bad enough in which to obtain foundations for ordinary work, without trying to build an underground conduit which cannot be drained."*

In this comprehensive quotation objections are raised on the score not only of the topography, but also of the geology, construction and drainage. But they are not specific, unless it be in the statement that "Philadelphia is nearly level." The elevation of the plateau is not stated, but it will be seen that the objection is inapplicable when it is remembered that ordinarily level country is that best adapted for railroad construction and operation. For underground roads it is particularly favorable, because of the light grades it affords. It is only necessary that the plateau be sufficiently elevated to permit the conduit to be placed between wind and water, or about twenty feet above datum, to remove most of those objections. It will be interesting to examine the site of the city denuded of its present structures, or as it appeared to the topographical engineers of Lord Howe's army of occupation in 1777–8. For this purpose I refer to the excellent map of that date, published in London in 1779. Although this chart gives no elevations, it shows the surface drainage, hills and ravines in relief and thus indicates the approximate position of the divides, which are the controlling lines in a project of this kind. A well-defined ravine is found extending across the northern

* See p. 22, Pamphlet entitled, *The Philadelphia and Reading Terminal R. R.* Dunlap & Clark, 819 Filbert St., Phila.

limits of the old city formed by the bed of Pegg's Run, or Cohoquinoque, and the southern slopes of Bush Hill and Fairmount.* This formed the line of defence of Lord Howe, who dammed the mouth of the creek and flooded the meadows for some distance. At a later date, 1796, it was the site of the canal partially built and intended to connect the two rivers. And still later it became the bed of the Philadelphia and Reading R. R., the creek having been encased in the sewer now underlying the roadway on Willow Street.

Concerning this locality, Watson says: "No part of Philadelphia has undergone such great changes as the commons bordering this run. At the north end the high table-land of the city terminated in a high precipitous bluff, at about 250 feet north of Callowhill Street. This extended from Front Street, at Pool's Bridge, up as high as Fifth and Sixth Streets, bounding the margin of Pegg's Run. On the north side of this whole range, there was an extensive marsh into which the Delaware flowed. Beyond this marsh was a high, open common. * * * The descent of Second Street, from Callowhill to the stone bridge, was nearly as great as at Race and Front Streets now. * * * In that time the short street (Margaretta), south of the bridge, did not exist, but the brick house, which forms the south side corner house, was the utmost verge of the ancient bluff. From Third to Sixth Streets, on the south side of Pegg's Run, being very high, furnished all the gravel used in the city end of the Germantown turnpike." It has been stated that at an earlier geological period the Schuylkill River crossed the peninsula through this ravine, converting the site of the city into an island. Thus it is seen that the Pegg's Run hollow (now Willow Street) has played an important part in the history of the city, both for transportation and defence, and that the topography is peculiarly favorable to the construction of an underground line, furnishing an easy and short transit to the surface at the east end.

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* The Secretary, Dr. WAHL, has prepared a slide from a rare and valuable atlas belonging to the library of the INSTITUTE.

As the north and west branches of the Reading system meet here on tide-water, it formed a natural point for transshipment, and hence an extensive terminus was constructed. Concerning this, it is pertinently asked by a prominent engineer: "Supposing a subway was made, how could connections be had with the company's freight yards on Pennsylvania Avenue and at Willow Street wharf, etc., and if the depressed road is to come to the surface at the wharf, what is to be done with the north and south streets that will be cut off? * * * Perhaps the advocates of the underground plan can answer these questions, but I cannot."

The answer to the query will be seen in the profile. Callowhill Street, from New Market west, lies above the twenty-two foot plane, and the former bluff at Margaretta Street enables a line to be built connecting the surface tracks on Delaware Avenue with the tunnel under Callowhill, without a grade crossing, by merely changing slightly the elevation of a short back street. It is a very simple and comparatively inexpensive case. As to the injury to the company from loss of patrons, it would not be serious, as they would still adhere to the company and move the coal-yards to the new location, while the company would be saved the annoyance, delays and expenses resulting from grade crossings, whereby an occasional life is sacrificed and a bill for damages is rendered. To determine the actual extent of this patronage between the Delaware River and Broad Street, where it would be necessary to shift the location slightly to the south, I made a *reconnoissance* of the route and found a total of only eighteen establishments having sidings connecting them with the line. Of these, eleven were coal-yards and the balance miscellaneous business. Out of the eight sidings on the south side, six led into coal-yards, and most of these extending through to Callowhill Street could be served as well from the subway under that thoroughfare. As a coal-yard is always on the move, it would seem to be a very simple matter to change its location slightly without great detriment to the business.

Upon a critical examination of the topography with reference to the proposed location, we find these objections

vanish, as there is no point where the difficulties cannot be overcome by well known expedients. Similar objections would have applied with much greater force to the Metropolitan Railway of London, and yet even there they have been successfully solved.

With reference to the geology, it may be said that the character of the subsoil can only be certainly known by numerous borings or by actual work in it, and that the statements concerning the beds of clay and underlying quicksands must be taken with large allowance. Doubtless there are spots or pockets of this description, but as a rule the material is well adapted for foundations and easily excavated. Prof. Hall, geologist, says: "The entire northern portion of Philadelphia County is covered by gravel, a greater portion of the south end of the city of Philadelphia is covered by mud. Flanking these deposits, a belt of Trenton gravel extends along the course of the river. This was deposited by the river before it had receded to its present channel. These gravels merge into the brick clays, red gravel and yellow gravel very variable in thickness. Through the southern portion of Philadelphia it is not far from one hundred feet in depth. There are exposures of this gravel in all sections of the city where streets have been graded down."

It would seem then that gravel would be the predominating material, and as this is easily worked, drains itself, forms a good foundation and has a commercial value, it ought to reduce the cost of such a work and prove an important adjunct.

The objections to drainage are met by a reference to the London experience, where the southern portion of the "Inner circle" traverses the old bed of the river and the swamps of Pimlico and Bridge Creeks. "As a matter of fact the average rail-level is thirteen feet below Thames high-water," and the District company operates five pumping stations between Kensington and Blackfriars. At Charing Cross the walls of the covered way had to be carried to a depth of thirty-seven feet below high-water, to secure a solid foundation, as this part of London is built largely on made ground and silt.

In the profiles suggested for Philadelphia, there are but two points where the grade falls a few feet below high-water. These are on Market Street, at Fourth and on South Broad at its intersection with Morris, where, if a large amount of water were encountered, pumps might be required, but by suitable constructions it is expected to avoid this expense,

Several other specific objections are made, but they are more imaginary than real, and time is wanting for their consideration. We may find it important, however, to review briefly the summary of the reasons for regarding the subway projects as impracticable. These are as follows: It is said that, "the road on Broad and Market Streets never should be accepted by the Reading Company for the following reasons:

(1) "Because it would be in the highest degree objectionable for the Reading Company to transfer all its business at Germantown Junction to another railroad owned by other persons."

The answer to this is that, if the Broad Street tunnel is to be owned and operated by a company hostile to the interests of the Reading R. R. and the city, then the objection is well founded, and it would be folly for the management of that road to undertake such an entrance; but it is entirely feasible for the Reading system to own, construct and control an independent tunnel from its lines on North Broad Street to Twelfth and Market, for, I believe, less money than the cost of the present route with its expensive right of way and damages. The plans for this project will be shown subsequently. Under these conditions the first objection would not be valid.

(2) "Because of the extreme cost of the proposed subway and of the necessary terminal facilities connected therewith."

For the municipal travel it is not necessary that the terminus should be under the surface. It may be placed wherever property is cheapest and supplies may be most readily obtained. Stations will cost but little and may be made a source of revenue. So, for a trunk line, it is injudi-

cious to seek for room underground for storage of engines, cars, fuel, water, repair-shops and general supplies. It is sufficient if there be space for the making up of trains and the handling of the traffic, and there is no difficulty in providing the required space for these purposes.

Now, as to the "extreme cost," perhaps a comparison can best be made by taking the estimate of the proposed Reading terminal from Glenwood Avenue to Ninth and Willow, and from Thirteenth Street, on Pennsylvania Avenue, to the Delaware River, as published under date of May 8th last, as a basis.

For this distance, which by the city map is found to be about 20,000 feet, it is stated that the approximate cost of an elevated railroad to replace the present surface tracks as they exist to-day, * * * including the construction of freight and passenger stations, etc., to give the railroad company facilities equivalent to what they now have, would cost $12,750,000. "This cost is exclusive of any property that might have to be purchased for yard purposes, and does not take into account the construction of an elevated road from Willow Street to Market Street." Thus, the cost of an elevated structure with stations, but exclusive of right of way, property, and damages, is found to be about $638 per lineal foot or $3,368,640 per mile.

In comparison with these figures, let us take the cost of actual tunnel work similar to that proposed. The Fourth Avenue Improvement is four and a half miles in length, and of this distance, 10,662 feet are in tunnel, and the balance viaduct and subway. There are four tracks occupying a cross section seventy-six feet in width, at some places, yet the cost per lineal foot was but $285 or $1,504,800 per mile, which is only forty-four per cent. of the above estimate for the elevated road without damages. This single instance should suffice to answer the second objection.

(3) "*Because of the impossibility of satisfactorily operating the subway.*"

Again, we may refer to actual precedents in reply to this statement. On the Philadelphia and Reading systems it is

asserted that there are about 200 trains passing over the crossings at Ninth and Green Streets. On the Connecting R. R. and Kensington Branch of the Penna. R. R. there are 174 trains daily. This would aggregate say 400 trains on both lines for a four track road (both ways) or 100 trains per track. On the Third Avenue elevated railway of New York, there are 490 trains going north and the same number coming south each day, or about five times the number of trains as are now running on the combined steam surface roads of this city, and their terminals are greatly contracted, being in the air.

(4) "*Because the subway plan cannot be adapted to the other lines of road operated by the Reading Company in Philadelphia.*"

An examination of the profiles will show how readily the proposed lines may be made to connect the Reading Station at Broad Street with the underground line on Pennsylvania Avenue and Callowhill Street, extending from the B. and O. tunnel to Delaware Avenue, and also with the P. G. and N. and North Penn or Bound Brook lines, making a complete connection and dispensing with a large number of grade crossings.*

(5) "*Because it would be unwholesome and unsatisfactory to the public.*"

The first part of this objection is doubtless supposed to result from improper ventilation, smoke, gases and darkness, a condition of affairs more or less imaginary, yet met, in part, by the antiquated precedent of the Metropolitan and District Underground Railway Companies, of London, which own and operate over forty-three miles of completed lines.

So also in numerous existing tunnels, unprovided as they are with any aids to ventilation, we find no injury to the travelling public from these or other causes, although their lengths greatly exceed those of the subways proposed here. Thus the Hoosac tunnel is very nearly five miles long, the

* The extensive profiles and plans accompanying this lecture, are not reproduced for manifest reasons.

Mt. Cenis about eight, and the St. Gothard over nine; without producing any complaints as to their unwholesome or unsatisfactory condition. In the lines proposed here from Twelfth and Market Streets to Glenwood Avenue, the length would be a little over three miles, with at least as many openings for ventilation, and on the Pennsylvania Avenue or Market Street divisions it is but a little more than two miles across the city. Moreover, engines can be made to retain their smoke for long distances, and in most cases the grades would be light, being within one-half of one per cent. or half of a foot per hundred, so that the anticipated evils of the underground way would doubtless be found to be imaginary. In a city like London, where the poor cannot well ride in cars, and the rich do not, to any great extent, the fact that 40,000,000 of people were carried on the underground roads during the first six months of this year, would seem to indicate that this mode of travel is not so unsatisfactory as to preclude its use. It should also be observed that the ratio of travel to population is generally much less in continental than in American cities. In London, for example, it is about seventy-seven to one for all lines, while in New York and Philadelphia it is about 125 to one for surface travel only.

The next objection as stated is:

(6) "Because it would forever preclude the growth of business on the lines of the Reading Company, and prevent any extensions in the future to meet increased business. The four tracks proposed on Broad Street would be fully occupied at once by the business of the Reading Company, and as the whole width of the street would be taken up, no more tracks could be provided in the future." * * "As for running both the Reading and Pennsylvania trains through the tunnel, that would be a physical impossibility, for there would not be room enough."

The answer to these statements has already been given.

The seventh and last of this group of objections is to the effect that, "The destruction of the Reading Railroad terminal facilities in Philadelphia would entail a loss on the city and its inhabitants impossible to estimate."

Such a result would doubtless prove to be a great calamity, but from what has already been presented in reply to the above arguments, it would appear that no such effect would follow the construction of the contemplated lines. On the contrary, they would serve as links to bind together more closely the now disjointed termini of this great railroad system, and thus greatly increase its facilities for expanding and handling its augmented business, while it would relieve the surface of a large number of dangerous crossings.

This review of these objections has necessarily been very brief, but if the answers are satisfactory they should go far towards preparing the way for the entrance upon the third stage of this important municipal development, viz: that of construction.

This leads us to the consideration of the peculiar physical difficulties which have, by some persons, been declared insuperable.

They partake of the nature of special problems, and are to be found at those points along the line where obstructions are encountered, involving a change of grade or of direction. Thus the necessity of passing underground from the surface at the foot of Market and of Willow Streets; of making the circuit of the Public Buildings; of rising from under west Market Street to cross the Schuylkill River and the Junction Railroad, and of reëntering the ground without crossing a street at grade; of providing independent lines for the business of the Reading and Pennsylvania Companies, and passing one over the other without a grade crossing; of connecting the branches of the Reading system by an underground line and not destroying its patronage; of connecting the northern and eastern traffic on both lines with their respective tunnels under Broad Street, thus greatly reducing the time and distance for local travel; of passing out from South Broad Street to the surface, and providing ready access to League Island, Girard Point, Point Breeze and other remote localities; also, of providing for the proper drainage, lighting and ventilation of the subway without destroying the city service or sewerage, and at

the same time providing for the large amount of local traffic which such an enterprise would develop.

These are some of the features of the general problem. The more important ones, and especially those declared to be impracticable by the advocates of other projects, have been carefully considered and satisfactorily solved.

[NOTE.—These solutions were explained by reference to the profiles.]

Thus it will be seen that these supposed impossibilities are all brought within the range of practicable limits, and so far as appearances indicate, the difficulties are of a much simpler character than those encountered in the London prototype.

Upon inquiry, and from personal examinations of a large number of deep foundations, and from the experience of well-diggers, I find that there is very little true quicksand to be met with within the limits of the required depth; that standing water is generally more than twenty-five feet below street grade; in some places it is over forty, and east of Second Street, on Market, it is believed to be even lower.*

The material generally is loam, clay and sand, underlaid with compact gravel, which gives an excellent foundation. In some instances, as on North Broad and West Market Streets, soft rock may be expected. In fine, the physical conditions are found to be unusually favorable.

But there is another class of objections arising from the financial considerations, and it is necessary to show that the probable revenues will pay a fair dividend upon the investment. This question was considered in my lecture before the INSTITUTE last November, but for the benefit of those who may not have access to the figures, I will state that the Fourth Avenue Improvement in New York, built only for use by steam railroads, and already referred to, cost at the rate of $1,504,800 per mile. About one-half of this is in tunnel, and the rest in viaduct or open cut work, which was almost if not quite as expensive.

*Col. C. E. Livingston, whose large experience with "driven wells," makes him an authority on this subject.

The Union Tunnel under the streets of Baltimore, built in 1871–73, twenty-six feet wide, double track, cost $247 per lineal foot or $1,304,160 per mile.

The Metropolitan Railway, of London, which ran under private property, and encountered many exceptional difficulties, cost $56,645,420, or about $2,360,000 per mile; of this amount more than half was for real estate, yet this company is now paying dividends of two and three-quarter per cent. on the ordinary stock and two and one-half on the surplus land stock.

The Berlin Elevated Railroad is reported to have cost $2,115,000 per mile, including the right of way. The Pennsylvania Railroad Company's Elevated Road on Filbert Street, in this city, cost at the rate of $1,604,480 per mile, whilst the Reading Company's estimate for elevating their tracks was at the rate of over $3,000,000 per mile, and the Manhattan Elevated Company, of New York, is capitalized at $1,055,000, with little or no damages paid.

From these comparisons it would seem that under favorable conditions an underground system should cost less than one which is elevated and the expense of maintenance would undoubtedly be greatly reduced.

It is worthy of note, in connection with the statement recently made, that the London underground road did not pay, and if it had to be done over again it would not be built; that the city of Glasgow, having all the benefit of the London experience, is just about inaugurating a similar project, extending for seven miles through the heart of the city and penetrating clay, sand, gravel and rock, and in two places dipping below the level of ordinary spring tides. "The estimated cost of the road is $5,655,000, of which $1,135,000 is for lands. Adding ten per cent. for contingencies, it brings the cost per mile, for construction, to about $885,000. The section is a double trackway about twenty-six feet in width.

As to the probable receipts, it has been shown that the local passenger traffic alone, in a city like Philadelphia, may safely be placed at three million per mile per annum, producing a revenue of over $200,000, which would be the

interest at five per cent. of four millions. But the revenue could be largely augmented by rentals, and tariffs on freights which could be handled largely at night, so that there would appear to be sufficient income in sight to provide for a much larger expenditure than the estimated average cost of the work, which is placed at one and a half million dollars per mile.

It is worthy of remark that in reviewing the history of the London road Mr. Jno. Fowler writes: "After the contract was let and the works had been let on the first section of the line, great public and professional interest was felt in the undertaking, but at the same time it was considered to be an experiment. At the monthly board meetings of the directors, he was often told that members of the board had been warned by engineers that the line never could be made, and that even if made, it could never be worked, and even if worked, that no one would travel by it." He adds, "This was rather discouraging, but he had studied the work carefully, and believed in it, and the directors believed in him, and he did make it, did work it, and the public travelled by it." Thus, after the lapse of a quarter of a century, we find history repeating itself, and similar predictions of failure are freely made in this city to-day, but it will be observed that they come from parties who presume that their interests may be injuriously affected by the construction of the proposed lines.

Because attention has been directed in this lecture, particularly to the feasibility of underground roads, I do not wish to be misunderstood as opposing any project which may increase the velocity of travel, and it is an encouraging sign to find that the members of Councils are disposed to consider every earnest effort made with this end in view, whether elevated or depressed.

In conclusion let us look briefly at the benefits to be conferred by such an improvement.

(1) The city is intersected and girdled by steam railroads "at grade," giving at least 25,000 train-crossings per day. About 500,000 passengers ride in the horse and steam cars daily, and it is scarcely possible to go any moderate

distance without having to cross an intersection, causing delays and risks.

By the underground lines a very large amount of this local movement will be provided for, the risks will be reduced and the speed be greatly increased.

(2) The areas available for residence will be greatly extended in consequence of the increased velocity of travel. It has been shown heretofore that this area is proportional to the square of the velocity and that for pedestrians the practical limit to the area of Philadelphia is six and three-fourths square miles; for street car travel, at the rate of three miles per half hour, it is thirteen and one-half square miles; for elevated travel, at the rate of six miles per half hour, it is fifty square miles; while for underground travel, at the rate of ten miles per half hour, it is 147 square miles.

In 1858, when the first street car line was opened, the built up part of Philadelphia covered about seven square miles, or it had just passed the pedestrian limits, and its greatest length was a little over four miles along Fifth and Sixth Streets, where the first track was laid. In other words, it was a two mile, or thirty minute, walk to the outskirts from the centre.

About ten years ago the city passed the half-hour limit of travel in street cars, yet, if we except the cable lines, no relief has been provided, and the exodus by the steam roads has grown to such proportions that they are taxed to their utmost capacity to accommodate the travel.

Increased velocity, accompanied by greater safety, also means increased valuation to suburban property, and augmented revenues, without raising the tax rate.

(3) It is so common an event to have our principal streets broken up by the numerous applicants for underground privileges, that the business men would doubtless find it convenient to have portable bridges or skids to enable them to load teams beyond the trenches, were it not for the car tracks which occupy the middle portion of the streets. In fact this nuisance has been carried so far, that not long since a contractor was obliged to enjoin one of the city officers from tearing up his recently laid pavement to lay pipes, at

least for a long enough time to enable him to have it approved and get his warrant. With suitable subways it would be possible to lay respectable pavements in this city, and it would save a large annual expense for repairs, cleaning and maintenance. Our present pavements are not conducive either to health, morality or humanity.

(4) The drainage of the portion of the city through which the subways passed would be very much improved.

(5) The convenience of through as well as local passengers would be met by a quicker transit and a saving of several miles of distance by the circuitous lines across the city. In fact, by some lines there is no connection for through travel and passengers must be transferred at considerable inconvenience and some additional expense to reach their destination. This may be avoided by the proposed lines, which will connect the terminals of the various railroads directly with each other by the shortest lines.

Much more might be said upon this subject, but I will only add that under the favorable conditions existing here, and with the precedents of successful operations abroad, those who do not believe in the feasibility of an underground railroad in Philadelphia must have very little confidence in the possibilities of a profession which has done so much to make life not only endurable but absolutely enjoyable, and which has added so greatly to the wealth and rapid development, not only of this country but of the world.

Civil engineers justly may be said to be civilizers.

[The lecture was closed by an exhibition of lantern projections showing sections of the various underground railroads in existence, or proposed.]

INDETERMINATE MULTIPLIERS FOR THE CONTINUOUS GIRDER.

By C. H. LINDENBERGER, C. E.

Mr. Merriman's system of indeterminate multipliers for the continuous girder has long been recognized as the most convenient method of solving this problem. I propose in the following article to develop that theory into a formula by which any set of equations may be solved which have the form of the Three Moment Equations, in which the unknown terms correspond to the pier moments, but *all other terms are entirely arbitrary and may have any value whatever, either real or imaginary.* The problem will however be discussed as if it were a problem of obtaining pier moments.

Let M be any pier moment;

l be the length of a span;

s be the number of spans:

y be the arbitrary term at the end of the equations.

The quantities $M, l,$ and $y,$ are to be defined by a subscript denoting which one is meant. The "y" quantities include all terms denoting the state of loading and height of supports, and need not be further defined than to show where they appear in the "Three moment" equations.

These equations will then be:

$$\begin{aligned}
2\,M_2\,(l_1 + l_2) + M_3\,l_2 - y_2 &= o \\
M_2\,l_2 + 2\,M_3\,(l_2 + l_3) + M_4\,l_3 - y_3 &= o \\
\&c. \quad \&c. \quad \&c. \quad \&c. \quad \&c. \quad \&c. \qquad (1) \\
M_{s-2}\,l_{s-2} + 2\,M_{s-1}\,(l_{s-2} + l_{s-1}) + M_s\,l_{s-1} - y_{s-1} &= o \\
M_{s-1}\,l_{s-1} + 2\,M_s\,(l_{s-1} + l_s) - y_s &= o
\end{aligned}$$

There being (s—1) equations.

Now suppose these equations multiplied by indeter-

minate multipliers, the first by D_2, the second by D_3, &c. &c., and the equations thus multiplied be added together, and arranged according to the moments, then we would have the following equation:

$$\left.\begin{aligned} & M_2\,(2\,D_2\,(l_1+l_2)+D_3\,l_2)-D_2\,y_2 \\ &+M_3\,(D_2\,l_2+2\,D_3\,(l_2+l_3)+D_4\,l_3)-D_3\,y_3 \\ &+\text{\&c.}\quad\text{\&c.}\quad\text{\&c.}\quad\text{\&c.}\quad\text{\&c.}\quad\text{\&c.}\quad\text{\&c.} \\ &+M_{s-1}\,(D_{s-2}\,l_{s-2}+2\,D_{s-1}\,(l_{s-2}+l_{s-1})+ \\ &\qquad\qquad +D_s\,l_{s-1})-D_{s-1}\,y_{s-1} \\ &+M_s\,(D_{s-1}\,l_{s-1}+2\,D_s\,(l_{s-1}+l_s))-D_s\,y_s \end{aligned}\right\}=o \qquad (2)$$

Now the problem is to find a set of multipliers so that *any pier moment at will*, that we may select, that we will designate by M_q, shall have the co-efficient Z_q, while at the same time the coefficients of all the other pier moments become $= o$, so that we can write

$$M_q=\frac{D_2\,y_2+D_3\,y_3+\text{\&c.}+D_{s-1}\,y_{s-1}+D_s\,y_s}{Z_q} \qquad (3)$$

and we must find a short and easy method of obtaining Z_q, and the value of each separate indeterminate multiplier and prove that the "Three Moment" equations are fully satisfied.

Assume the following set of equations:

$$\begin{aligned} D_1\,l_1+2\,D_2\,(l_1+l_2)+D_3\,l_2&=Z_2 \\ D_2\,l_2+2\,D_3\,(l_2+l_3)+D_4\,l_3&=Z_3 \qquad (4) \\ \text{\&c.}\qquad\qquad\text{\&c.}\qquad\qquad\text{\&c.}\qquad\text{\&c.}& \\ D_{s-2}\,l_{s-2}+2\,D_{s-1}\,(l_{s-2}+l_{s-1})+D_s\,l_{s-1}&=Z_{s-1} \\ D_{s-1}\,l_{s-1}+2\,D_s\,(l_{s-1}+l_s)+D_{s+1}\,l_s&=Z_s \end{aligned}$$

There being also $(s-1)$ of these equations.

(1) Write c for D in these equations, assuming that $c_1=o$, $c_2=1$, and that $c_{s+1}\,l_s=-Z_s$, and substitute o for the Z^s on the right. These will be the c multipliers of Mr. Merriman.

(2) Write d for D in these equations, assuming that

$d_s = 1$, $d_{s+1} = o$, and substitute o for the Z^s on the right, as before. These will be the d multipliers of Mr. Merriman, but their subscripts are different because they are numbered the other way. These subscripts become the same as his by changing their sign and adding $(s + 2)$.

(3) Let any general multiplier be denoted by the sign $[q]_n$ instead of D in equations (3) and (4), and let the enclosed q be the subscript of the pier moment that is to be found, and let its own subscript n denote the place of that multiplier in its own series. There being as many series as there are pier moments. Also assume that $[q]_1 = o$, $[q]_2 = 1$, $[q]_{s+1} = o$, and that all the Z^s in equation (4) $= o$ except Z_q, then we have

$$[q]_{q-1}\, l_{q-1} + 2\,[q]_q\,(l_{q-1} + l_q) + [q]_{q+1}\, l_q = Z_q \qquad (5)$$

These multipliers in this form must be transformed, because this is altogether too complex a formula.

Now the equations for the determination of $[q]_n$, where n is equal to or less than q, are the same as those for c_2, c_3, *&c.* Hence

$$[q]_n = c_n \text{ for } n = \text{or} < q \qquad (6)$$

Also the equations for determining the relation between $[q]_n$ and $[q]_s$ are the same as those for the relation between d_n and d_s, and, therefore, we have

$$\frac{[q]_n}{[q]_s} = \frac{d_n}{d_s} = d_n \text{ since } d_s = 1 \qquad (7)$$

$$\text{for } n = \text{or} > q$$

and making $n = q$ Eq. (6).

$$[q]_s = \frac{c_q}{d_q} \qquad (8)$$

and therefore

$$[q]_n = \frac{c_q}{d_q}\, d_n, \text{ for } n = \text{or} > q \qquad (9)$$

and by substitution in Eq. (5), we have

$$c_{q-1}\, l_{q-1} + 2\, c_q\,(l_{q-1} + l_q) + \frac{c_q}{d_q}\, d_{q+1}\, l_q = Z_q \qquad (10)$$

This, however, may be simplified still more by a little

reduction. The corresponding equations for the c and d multipliers are:

$$c_{q-1}\,l_{q-1} + 2\,c_q\,(l_{q-1} + l_q) + c_{q+1}\,l_q = o \qquad (11)$$

$$d_{q-1}\,l_{q-1} + 2\,d_q\,(l_{q-1} + l_q) + d_{q+1}\,l_q = o \qquad (12)$$

and from Eq. (11), we get

$$c_q\,d_{q+1} - c_{q+1}\,d_q = \frac{Z_q\,d_q}{l_q} \qquad (13)$$

Multiply Eq. (11) by d_q and Eq. (12) by c_q and subtract, and we have

$$(c_{q-1}\,d_q - c_q\,d_{q-1})\,l_{q-1} - (c_q\,d_{q+1} - c_{q+1}\,d_q)\,l_q = o \qquad (14)$$

whence by comparison with Eq. (13)

$$Z_{q-1}\,d_{q-1} = Z_q\,d_q$$

and since q may have any of the successive values from 2 to s, inclusive, we have

$$d_2\,Z_2 = Z_q\,d_q = d_s\,Z_s = Z_s = c_{s-1}\,l_{s-1} + 2\,c_s\,(l_{s-1} + l_s) \qquad (15)$$

because $d_s = 1$ and from Eq. (10) making $q = 2$

$$2\,d_2\,(l_1 + l_2) + d_3\,l_2 = d_2\,Z_2 = Z_s \qquad (16)$$

If we use Mr. Merriman's notation this would be

$$2\,d_s\,(l_1 + l_2) + d_{s-1}\,l_2 = d_s\,Z_2 = Z_s$$

The identity of this expression with Z_s is apparent as soon as we find the numerical values of the multipliers, but *seems to have been treated hitherto as a mere coincidence* by most authors, including Mr. Merriman himself. It simplifies formulas and also furnishes a valuable check on the calculations.

By the aid of Eqs. (6), (9) and (15), the formula for the pier moment becomes apparent, and is

$$M_q = \frac{d_q}{Z_s}\,(c_2\,y_2 + c_3\,y_3 + \&c. + c_{q-1}\,y_{q-1} + c_q\,y_q) +$$

$$+ \frac{c_q}{Z_s}\,(d_{q+1}\,y_{q+1} + d_{q+2}\,y_{q+2} + \&c. + d_{s-1}\,y_{s-1} +$$

$$+ d_s\,y_s) \qquad (17)$$

and the rule for writing this formula is very simple. Thus

let y_n be any final term. Then if n be equal to or less than q its numerator coefficient is $d_q\ c_n$, but if n be either equal to or greater than q it becomes $c_q\ d_n$. For $n = q$, the coefficient is $c_q\ d_q$.

Hence,

$$M_1 = M_{s+1} = o$$

by this formula also.

Now since the values of the y^s have not entered the discussion, we may assume *any arbitrary values whatever* for them. If, however, we use the usual values as given in works on the continuous girder, then for supports all on a level and only one span loaded, this formula is the same as Mr. Merriman's, since only two of the y^s appear in the formula, all the rest being put $= o$. It must be remembered, however, that in this formula the subscripts of the d multipliers have been changed. This agreement with Mr. Merriman's formula is, of course, the necessary result of using his system of multipliers. There is, moreover, no special reason why the quantities l_1, l_2, &c., should be real and positive except the nature of the problem usually solved in this manner, viz: the continuous girder. Hence, if necessary, these may either be negative or imaginary also.

In order to test this formula by the "Three Moment" Equation, we must write the formulas for M_{q-1} and M_{q+1} which are developed the same way:

$$M_{q-1} = \frac{d_{q-1}}{Z_s}(c_2 y_2 + c_3 y_3 + \&c. + c_{q-1} y_{q-1}) +$$

$$+ \frac{c_{q-1}}{Z_s}(d_q y_q + d_{q+1} y_{q+1} + \&c. + d_{s-1} y_{s-1} + d_s y_s) \qquad (18)$$

$$M_{q+1} = \frac{d_{q+1}}{Z_s}(c_2 y_2 + c_3 y_3 + \&c + c_{q-1} y_{q-1} + c_q y_q +$$

$$+ c_{q+1} y_{q+1}) + \frac{c_{q+1}}{Z_s}(d_{q+2} y_{q+2} + \&c. + d_{s-1} y_{s-1} + d_s y_s \quad (19)$$

Multiply Eq. (18) by l_{q-1}; Eq. (17) by $2\ (l_{q-1} + l_q)$, and Eq. (19) by l_q, and add the products and arrange as coefficients of $y_2\ y_3$ &c. $\_\_\_\ y_s$. The quantities $c_2\ y_2$, $c_3\ y_3$ &c., up to and

inclusive of $c_{q-1}\, y_{q-1}$, will have a common numerator coefficient.

$$= d_{q-1}\, l_{q-1} + 2\, d_q\, (l_{q-1} + l_q) + d_{q+1}\, l_q = o \text{ [Eq. (12)]}$$

The numerator coefficient of y_q will be

$$d_q c_{q-1}\, l_{q-1} + 2\, c_q\, d_q (l_{q-1} + l_q) + c_q\, d_{q+1} l_q = Z_q\, d_q = Z_s \text{ [Eq. (10)]}$$

The numerator coefficient of $d_{q+1}\, y_{q+1}$, $d_{q+2}\, y_{q+2}$, &c., up to and inclusive of $d_s\, y_s$, will be

$$c_{q-1}\, l_{q-1} + 2\, c_q\, (l_{q-1} + l_q) + c_{q+1}\, l_q = o \text{ [Eq. (11)]}$$

and the equation of "Three Moments,"

$$M_{q-1}\, l_{q-1} + 2\, M_q\, (l_{q-1} + l_q) + M_{q+1}\, l_q - y_q = o$$

is fully satisfied, *which was to be proved.*

I have thus demonstrated that there is no theoretical necessity either for the hypothesis of single spans in succession loaded, or for the use of *b* multipliers dependent on the cubes of the spans or any hypothesis as to heights of supports, but that all can be solved by the aid of Mr. Merriman's *c* and *d* multipliers alone by this method.

Moreover, while I have written of pier moments and spans, the argument would have been fully as valid if I had called them simply unknown quantities and their coefficients, if the equations followed the same law. It is, therefore, a solution of any set of equations relating to any subject whatever if these equations have the form of those of the "Three Moments."

ELECTRIC WELDING.*

By C. J. H. Woodbury, Boston, Mass.

The smith is the highest type of handicraftsman; he, alone of all artisans making his own tools and also those of others, commands the dependence of all upon his offices. His work is pre-historic, reaching beyond records or traditions and known to have existed in still earlier times through the personifications of mythology, wherein Vulcan was essential to other divinities. The blacksmith is a factor in every stage of the history of mankind; and his work is now, and always has been a matter of individual skill, depending upon a keen eye and steady hand, with a fine sense of form and dimension, untouched by the flood of invention which has modified or even recast other methods of production.

It is true that machinery is used in welding, but it is merely devoted to the application of power to supplement the limits of human strength; and with trip hammer and crane the same skill is necessary as with hammer and anvil.

Since the first of the year there has been a commercial application of electric welding, the invention of Prof. Elihu Thomson, which has already reached a degree of importance sufficient to render it a live issue in every branch of manufacture to which it has been shown to be applicable.

This process is a new art, for unlike the smith who is confined to iron, steel and platinum, it can weld any two pieces of the same metal or alloy ranging from the most refractory metals to the alloy which fuses at 162° F. It will join dissimilar metals when the welding point of one is not too far in excess of the fusion point of the other.

These results seem to indicate that the classification of metals into welding and non-welding has been due to im-

* Presented at the Twenty-third Meeting, Scranton, Pa., Oct., 1888. American Society of Mechanical Engineers. Advance sheets from vol. x. *Transactions*, cccxxix.

perfections in the ordinary and time-honored methods, rather than any peculiarity in physical constitution warranting such arbitrary classification.

It is true that some of the metals have been joined without solder by means of the autogenous soldering process, wherein local fusion is produced with an oxy-hydrogen blowpipe, but that laboratory experiment is not a union of metals heated to a plastic condition which precedes fusion, according to the accepted meaning of welding.

Passing by the scientific interest of electric welding, a short allusion will be made to the principles upon which it is based, as preliminary to a description of the apparatus, and then consideration will be given to its practical applications.

THE PRINCIPLES.

All forms of matter possess in varying degree the susceptibility of permitting the molecular motion necessary for the transfer of electric energy; those whose characteristics are favorable for such motion being termed conductors, and those which do not readily permit such motions being called non-conductors or insulators; and various adjectives are frequently used to express in a general way some sense of their value, but throughout the whole list of all known matter, there is some measure of conductivity, and the whole expression is one of degree; the conductivity of silver, for example, being over one hundred billion times that of glass; and other materials possess measures of conductivity lying between these extremes. The ability of any body to conduct electricity in comparison with others of its kind is directly as the area of the cross-section and inversely as the length.

Whenever electricity is provided with what is termed a good conductor, it makes no manifestation of its presence, but if there is poor conductivity by reason of small cross-section or poor conductivity of the material, there is resistance to the electricity. Then a portion of the electric energy is expended in producing excessive molecular motion, and converted into heat, which is radiant if the temperature

is high enough, as in the case of the incandescent light, when the metal portion of the circuit possesses ample conductivity to carry the electricity without appreciable heating, but the carbon filament in the lamp is a poor conductor, both in regard to physical characteristics of the material and small cross-section, and the molecular motion is so violent as to produce a temperature sufficiently great to contain light rays.

The total amount of mechanical work done by a current C in overcoming a resistance R during a time T, is RC^2T; and the equivalent amount of heat is obtained by dividing the expression by J, the mechanical equivalent of heat.

$$H=\frac{RC^2T}{J}.$$

In an induction coil, electricity of large current and low pressure is converted into an equivalent electrical energy of small current and high pressure, by means of a bar of soft iron or a bundle of wires, wrapped with two coils of insulated wire of different lengths and diameters. An alternating current being sent through the shorter wire alternately magnetizes and demagnetizes the iron bar with reversed magnetic polarity, and reversals of magnetism in this bar in turn produce an alternating current in the circuit of which the secondary coil is a portion; the secondary current being as stated above of high potential and small quantity.

By suitable structural changes, an induction coil can be inverted as to its functions, and used to convert small electric currents into large ones, with inverse changes in potential.

THE APPARATUS.

The electricity is generated by one of two methods. In the direct system, the dynamo is contained in the machine below the clamps, and the armature contains two windings; the one being a fine winding which is in series with the field magnet coils, and the other winding being merely a bar of copper in the form of a letter U or less than a single

coil. This bar being of very low resistance, the maximum current is sufficient for welding purposes, and the terminals are connected directly to the copper clamps. Alternating currents are generated in this machine, and used for welding, in order to avoid commutators, which are necessary in direct current machines. It should be remembered that in all dynamos the electricity is generated in alternating currents, and that these currents are in proper turn fed to brushes of opposite polarity, and thus rendered continuous. In an alternating current dynamo, the electricity is conducted from the armature to rings instead of to a commutator, and is thus better suited for large currents, and some forms of the apparatus do not require rings or any moving contacts. There is no electrical reason why an alternating current should be used, except the convenience of its manipulation. In fact, the continuous current supplied by secondary batteries has been used for this purpose.

Another form of apparatus, termed the indirect system, is more conveniently suited for large work, or in places where a number of welding machines are operated by the current from a single dynamo. The welding current is produced by conversion of the comparatively high tension current by means of an inverted induction coil, termed a transformer. The primary circuit from the dynamo is conducted through many turns of fine wire wound round a soft iron ring, and upon this same ring is a single turn of a large copper bar in which the welding current is produced by inductive effect. These currents receive 4,000 to 15,000 alternations per minute. The welding currents are not changed suddenly or by switches, as such manipulation would not be desirable or even practicable with the great currents used; but in the direct welding machine, a set of resistance coils is placed in the fine circuit which passes around the field magnets, and by interposing more or less of the resistance coils in this circuit, the strength of the magnets is diminished or increased, and the welding current altered accordingly.

With the indirect machine, the amount of the secondary or welding current is controlled by varying the current in

the primary coil by means of a variable shunt to the field coils and in other ways.

In either case the apparatus is simple, and is in full and complete control at will of the operator by the movement of a lever, and this action controls the heat.

THE PROCESS.

In the electric welding process, the two pieces to be joined are secured in firm end contact by a pair of adjustable copper clamps which are placed upon the top of the apparatus. An electric current of large volume is passed through the pieces, and the contact between them being of less conductivity than the homogeneous metal, heating ensues at this place, as the juncture is brought to the proper temperature by the gradual motion of the regulating lever, and as the metal softens, the clamps are pressed towards each other to insure a continuous metallic union across the bar.

The weld begins at the centre and proceeds radially towards the surface, as the temperature becomes greater than at the interior. The heating is further increased by the fact that the resistance of the hot metal is greater than that of cold metal.

The enormous electric currents used in this welding process sometimes reach 50,000 amperes, but with an electromotive force of half a volt, and therefore not capable of giving any sensation to a person.

It would be injudicious to offer any premium upon ignorance, but the operation of electric welding is one of the simplest of mechanical processes, requiring but little skill on the part of the operator in comparison with that exact training of hand and eye and long experience necessary for ordinary welding. The operator must understand the color of the proper welding heat of the metal under treatment, but this is readily learned. The work is not manipulated during the process, except when it is desired to reduce the burr at the weld, and is at all times under observation, and its heat subject to entire control by means of a lever which graduates the strength of the current.

The dynamo generating the electricity is self-regulating, and requires no attention except for lubrication.

There is no unnecessary waste of fuel, as the heating, being local, does not extend far from the weld; cotton-covered wire, one-fourth of an inch in diameter, can be welded without searing the insulation over three-fourths of an inch from the weld.

The time for making a weld varies from a fraction of a second to about two minutes, according to the work; although nothing over two inches diameter has yet been welded, but larger machines are in process of construction.

It is not necessary to provide motive power fully equal to the maximum demand, as the time is so short that the momentum of a fly-wheel will serve the same purpose as in a drop press, and give up the surplus energy required.

The power is inversely proportional to the time and appears to be about proportional to the 2·3 power of the diameter in inches, with a slight variation in favor of quick work, caused by differences in rates of thermal conductivity of the material.

APPLICATIONS.

The process is far cheaper than that of hand welding, and also extends to other methods of manufacture, but the comparative expense differs according to the previous conditions in every place where it has been applied thus far.

Its applications in practical work thus far have been confined to butt welding for many purposes, such as continuous wire work, carriage work, axles and tires, cotton-bale ties, barrel hoops and wire cables and many miscellaneous purposes. Axes are made of drop forgings, joining the tool steel edge to a mild steel poll, bars are heated in the middle and upset forming collars, and pipes are joined together—a matter of great value in ice machines. The list might be continued to greater length, but this indicates the range of its practical uses at this early day.

STRENGTH OF ELECTRIC WELDS.

The value of the process, for most purposes, independent from any scientific interest or mechanical ingenuity shown

in the apparatus, must be that of the resistance of the welds under tensile stress.

It will readily be understood, however, that, as this process accomplishes many things hitherto impossible, aside from any question of ultimate strength, it is fitted for applications in many constructions where it saves labor and time; provided only that the joints be in all cases sufficiently good for the purpose for which the article is designed. A large field thus opens up in the execution of ornamental design in metal work, where it will supplant screws, rivets or solder for fastenings, and in other evident applications.

There is no reason why such a weld should be stronger than the rest of the bar, but if averaging of equal strength some of the breaks would occur at the weld. There have been many tests made on various testing machines, but it has been considered preferable to submit only the official record of tests made on the Emery Testing Machine at the U. S. Arsenal at Watertown, Mass. (*See accompanying table.*)

[There were exhibited a number of specimens of electric welding showing the range and capability of the process.]

4,728	Octagon	at steel and wrt. iron,	16·	·65	"	·332	·63	"	·328	17,100	52,130	In iron, 3 in. from weld,	Fibrous,				
4,729	. . . .	"	16·	·75	"	·442	iron, ·63	"	·328	17,070	52,040	" 2·3 "	"	seamy,			
4,730	. . . .	"	16·	·77	"	·466	·63	"	·328	16,950	51,680	" 2 8 "	"	"			
4,731	. . . .	Copper, ...	12·	Not welded, ...			·373	"	·109	3,580	32,840	. . . . .					
4,732	. . . .	"	12·	"			·373	"	·109	3,540	32,480	. . . . .					
4,733	. . . .	"	12·	"			·373	"	·109	3,530	32,390	. . . . .					
4,734	D.	"	11·75	·380 diam. =		·113	·373	"	·109	3,210	29,150	At weld, ...					
4,735	D.	"	11·80	·380 "		·113	·373	"	·109	3,390	31,100	"					
4,736	D. H.	"	11·8	·372 "		·109	·373	"	·109	3,470	31,830	"					
4,737	D. H.	"	11·8	·379 "		·113	·373	"	·109	3,590	32,940	¼ inch from weld, . . .					
4,738	P. W.	"	11·85	·51 "		·204	·373	"	·109	3,540	32,480	¼ " " . . .					
4,739	P. W.	"	11·80	·50 "		·196	·373	"	·109	3,570	32,750	·85 " " . . .					
4,740	. . . .	Brass, ...	12·	Not welded, ...			·374	"	·110	5,240	47,640	. . . . .					Has been heated at middle
4,741	. . . .	"	12·	"			·374	"	·110	5,275	47,950	. . . . .					Have been heated at middle.
4,742	. . . .	"	12·	"			·374	"	·110	5,240	47,640	. . . . .					
4,743	D.	"	11·8	·375 diam. =		·110	·374	"	·110	4,490	41,820	At weld, ...					
4,744	D.	"	11·8	·375 "		·110	·374	"	·110	5,250	47,730	¼ inch from weld, . . .					
4,745	P. W.	"	11·9	·50 "		·196	·374	"	·110	5,270	47,910	¼ " " . . .					
4,746	P. W.	"	11·8	·50 "		·196	·374	"	·110	5,270	49,910	·80 " " . . .					
4,747	. .	Brass and wrt. iron,	10·3	·374 "	Brass,		·374	"	·110	1,920	17,450	At weld, ...					
4,748	. .	"	11·5	·374 "			·374	"	·110	3,630	33,550	"					
4,749	Steel	and German silver, .	9 15	·33 "		·086	·250	"	·049	1,980	40,410	"					
4,750	D.	Copper, ...	11·9	·378 "		·112	·373	"	·109	3,520	32,290	"					
4,751	P. W	Wrought iron, . . .	13·25	·68 "		·363	·50	"	·196	11,420	58,37	1·3 inch from weld, . .	Fibrous,				
4,752	P. W.	. . . . .	13·15	·70 "		·385	·60	"	·196	10,410	53,110	1·7 " " . .	"				

4,753. A chain made of three links of ·50 inch diameter wire. Two welds in each link at the sides. Tensile strength, 17,900 pounds. Fractured middle link in the quarter 1·63 inch from weld. Appearance fibrous.

Test No.	Marks.	Metal.	Total Length.	Diameters.		Sectional Areas.		Tensile Strength		Position of Fracture.	Appearance of Fracture.
				At Weld.	Of Bar.	At Weld.	Of Bar	Total Lbs.	Lbs. per sq. in. on Bar.		
			Ins	*Inches.*	*Inches.*	*Sq. In.*	*Sq. In*				
4,779	1	Steel, ...	15·6	·504	·503	·200	·199	15 290	76,830	At weld, ...	Gr. medium coarse.
4,780	2	"	15·4	·62	·500	·302	·196	21,700	110.710	8 inches from weld, ...	Gr fine, dull centre
4,781	3	"	14·1	500	498	·196	·195	14.590	74,820	At or near weld.	In part smooth and part gr.
4,782	C.	"	18·1	Not welded.	·502	. . .	·198	15,000	75.450	Near end of heated sec'n, ...	Fine gr., dull centre,
4,783	H.	"	15 25	·62	·500	·302	·196	20,420	104.180	9 inches from weld, ...	Fine gr., dull centre.
4,784	C*	Octagonal steel,	19 6	82	·55	·557	·250	31,190	124 760	At weld, ...	Dull spongy, irregular dark spots.
4,785	D.	"	19 8	·58	·55	·278	·250	33 580	134,320	At weld, ...	Gr. medium coarse.
4,786	H. D.	"	19 7	·55	·55	·250	·250	32 350	129,400	3 inches from weld, ...	Fine gr. rad. from dull spot at circ.
4,787	H. D.	"	19 8	·55	·55	·250	·250	33.700	134,800	At weld, ...	Gr. medium coarse.
4,788	. .	Steel, ...	16·	Not welded.	·62	. . .	·302	19,610	64 930	. . . . .	Fine silky.
4,789	P. W.	"	15·9	·80	·62	·503	·302	19,490	64,540	9 inches from weld, ...	Fine silky.
4,790	D.	"	15·8	·62	·62	·302	·302	19,020	62,980	At weld, ...	Gr medium coarse.
4,791	. .	Wrought iron, .	16·1	Not welded.	·63	. . .	·312	16 360	52 440	. . . . .	Fibrous
4,792	H. D.	"	16·1	·63	·63	·312	·312	16,280	52,180	At or near weld.	Fibrous, light colored at circ.
4,793	D.	"	16·	·63	·63	·312	·312	16,160	51,790	At or near weld, ...	Fibrous.
4,794	H.	"	16·25	·72	·63	·407	·312	16,750	53,690	2·4 inches from weld, ...	Fibrous. seamy.
4,795	H. D.	"	16·25	·76	·76	·454	·454	24.550	54.070	At weld	Gr. at circ., dull centre.
4,796	H.	"	16·1	·88	·76	·608	·608	25.590	42.100	2 inches from weld, ...	Fibrous.
4,797	H.	"	16·4	·81	·76	·515	·515	25,390	49,300	2 inches from weld, ...	Fibrous.
4,798	H. D.*	Steel, ...	15·5	·509	·502	·203	·198	15,300	77,270	At or near weld, ...	Gr. medium coarse.

Correct.
J. E. HOWARD.

F. H. PARKER,
Lieut.-Col. Ordnance Dept. U. S. A., Commanding.

Ordnance Department, U.S.A.—Reports of Tests by Tension of Bars Joined by Electric Welds, at the Testing Machine, U. S. Arsenal, Watertown, Mass.

Test No.	Marks.	Metal.	Total Length.	Sectional Areas. At Weld.	Sectional Areas. Of Bar.	Tensile Strength. Total Pounds.	Tensile Strength. Pounds. Sq. inches in Bar.	Position of Fracture.	Appearance of Fracture.	Remarks.
			Ins.	*Inches. Sq. Ins.*	*Inches. Sq. Ins.*					
4,695	. . .	Wrought iron, . . .	31·75	1·74 diam. = 2·39	1·50 diam = 1·77	79,640	45,070	3½ in. from middle of weld, ...	Fibrous gr. spot at circumference, ...	Weld finished with hammer.
4,696	. . .	"	36·25	1·22 " 1·17	1·24 " 1·21	57,900	49,500	At weld, ...	Gr., ...	" " "
4,697	. . .	"	36·	1·00 " 7·85	1 00 " 7·85	42,690	54,380	3 inches from weld, . .	Fibrous, ...	" " "
4,698	. . .	"	11·9	Not welded, ...	1·02 × ·40 = ·408	21,920	53,730	. . . . .	"	Has been heated at middle.
4,699	. . .	"	11·9	"	1·02 × ·40 = ·408	21,840	53,530	. . . . .	"	" " " "
4,700	. . .	"	11·9	"	1·02 × ·40 = ·408	22,780	55,830	. . . . .	"	" " " "
4,701	H. D.	"	13·	1·02 × ·40 = ·408	1 02 × ·40 = ·408	20,100	49,260	At weld, ...	"	. . . . .
4,702	H. D.	"	12·8	1·02 × ·40 = ·408	1 02 × ·40 = ·408	21,020	51,520	"	"	. . . . .
4,703	H. C.	"	12·8	1·17 × ·48 = ·562	4·02 × ·40 = ·408	21,820	53,480	3 inches from weld, . .	"	. . . . .
4,704	H. C.	"	12·9	1·14 × ·45 = ·513	1·02 × ·40 = ·408	21,810	53,480	At weld, ...	Dull fibrous, in part gr. .	. . . . .
4,705	H. H.	"	12 9	1·13 × ·49 = ·513	1·02 × ·40 = ·408	20,400	50,000	"	" " and spongy,	12,000 lbs comp. accidentally applied before tension test.
4,706	H. H.	"	12·9	1·18 × ·51 = ·602	1·02 × ·40 = ·408	22,240	54,510	2¼ inches from weld, .	Fibrous, ...	. . . . .
4,707	W.	"	12·8	1·18 × ·47 = ·555	1·02 × ·40 = ·408	21,780	53 380	3·7 " " " .	"	. . . . .
4,708	. . .	"	12·	Not welded, ...	·50 diam. = ·196	12 570	63,880	. . . . .	"	Has been heated at middle.
4,709	. . .	"	12·	"	·50 " ·196	11,160	56,940	At the grip, ...	"	" " " "
4,710	. . .	"	12·2	"	·50 " ·196	10,520	53,670	. . . . .	"	" " " "
4,711	H. D.	"	13·2	·49 diam. = ·189	·50 " ·186	7,690	39,230	At weld, ...	Dull fibrous, part of surface smooth, ...	. . . . .
4 712	H. D.	"	13·35	·50 " ·196	·50 " ·196	9,980	50,920	"	Dull fibrous, and spongy,	Started fine crack at weld.
4,713	H. H.	"	13·2	·60 " ·283	·50 " ·196	10,260	52,350	1½ inch from weld, . .	Fibrous, ...	Fractured at weld at the anvil by bending cold.
4,714	H. H.	"	13·2	·60 " ·283	·50 " ·196	10,280	52,450	1·6 " " " .	"	Fibrous, part of surface smooth.
4,715	H. C.	"	13 35	·56 " ·246	·50 " ·186	11,080	56,530	1·75 " " " .	"	
4,716	H. C.	"	13 2	·61 " ·292	·50 " ·190	10,270	52,400	1 8 " " " .	"	
4,717	P. W.	"	13 2	·67 " ·353	·50 " ·196	11,170	56,990	1·5 " " " .	"	. . . . .
4,718	P. W.	"	13 2	·67 " ·353	·50 " ·196	10,060	51,330	1·7 " " " .	"	. . . . .
4,719	P. W.	"	13 2	·69 " ·374	·50 " ·196	10,120	51,630	1·5 " " " .	"	. . . . .
4,720	. . .	"	16·1	Not welded, ...	·62 " ·302	15,700	51,990	. . . . .	"	. . . . .
4,721	. . .	"	16·	"	·62 " ·302	17,980	59,540	. . . . .	"	. . . . .
4,722	. . .	Octagonal steel, . .	16·	"	·66 " ·360	45,800	127,220	. . . . .	Fine gr. radiating from a spot at circumference,	. . . . .
4,723	. . .	"	16·	"	·66 " ·360	45,670	126,860	At face of grips, . . .	Fine gr. radiating from a spot at circumference,	. . . . .
4,724	. . .	"	15·75	·66 diam. = ·360	·66 " ·360	27,500	76,390	At weld, ...	Coarse gr., ...	. . . . .
4,725	. . .	"	16	·67 " ·372	·66 " ·360	22,900	63,610	"	Coarse Gr., yellow cast at circumference, . . .	. . . . .
4,726	. . .	"	16	·80 " ·531	·66 " ·360	32,550	90,420	At end of enlarged section of weld	Coarse gr., ...	. . . . .
4,727	. . .	"	16·	·78 " ·502	·66 " ·360	37,800	105,000	At end of enlarged section of weld, ...	" "	. . . . .
4,728	Octagon	al steel and wrt. iron.	16·	·65 " ·332	·63 " ·328	17,100	52,130	In iron, 3 in. from weld,	Fibrous, ...	. . . . .
4,729	. . .	"	16·	·75 " ·442 iron,	·63 " ·328	17,070	52,040	" 2·3 " "	" seamy, ...	. . . . .
4,730	. . .	"	16·	·77 " ·466	·63 " ·328	16,950	51,680	" 2 8 " "	"	. . . . .
4,731	. . .	Copper, ...	12·	Not welded, ...	·373 " ·109	3,580	32,840	. . . . .	. . . . .	. . . . .
4,732	. . .	"	12	"	373 " ·109	3,540	32,480	. . . . .	. . . . .	. . . . .
4,733	. . .	"	12·	"	·373 " ·109	3,530	32,390	. . . . .	. . . . .	. . . . .
4,734	D.	"	11·75	·380 diam. = ·113	·373 " ·109	3,210	29,450	At weld, ...	. . . . .	. . . . .
4,735	D.	"	11·80	·380 " ·113	·373 " ·109	3,390	31,100	"	. . . . .	. . . . .

A PERFECT SUBSTITUTE FOR GLASS AS A SUPPORT FOR GELATINE BROMIDE OF SILVER FOR USE IN PHOTOGRAPHY.

By Jno. Carbutt.

[*Read at the Stated Meeting, Wednesday, November 21, 1888.*]

Vice-President Chas. Bullock, in the Chair.

No sooner had the gelatine dry plate process become established, displacing by its greater sensitiveness and convenience the old wet and dry collodion method, than experiments were commenced to find a suitable substitute for glass, the weight of which has proved a great inconvenience to travellers, with the dread always present that their exposed plates or negatives might get broken; a dread, in many instances, only too painfully realized. Before proceeding to describe the material I have found to be a perfect substitute for glass as used in photography, I will briefly pass in review a few of the substitutes suggested and made use of, and note the objections to them.

In 1880, M. Ferrier, of Paris, patented a compound film of gelatine and collodion. The objection to this film was the unequal expansion of the gelatine and collodion, causing the latter to crack.

H. J. Palmer, M.A., of Liverpool, in 1881, proposed a film of gelatine and ox-gall, with a second film of plain gelatine.

Stebbing, of Paris, produced gelatine bromide films on a pellicle of gelatine. Both this and the Palmer film proved defective from the liability of the film to expand while in the developing solution, sometimes to nearly double the area of the dry film.

Warnerke, of London, produced films of alternate layers of rubber and collodion.

Pumphrey, of Birmingham, as early as 1882, produced films on paper.

Morgan & Kidd, of London, coated paper for bromide enlargements, and the same was used for paper negatives, but the grain of the paper proved objectionable.

The late Walter B. Woodbury devoted a great deal of time in trying to produce a transparent paper as a support, when death overtook him. His partner, Vegara, took it up, and finally placed such films on the market, only to be shortly withdrawn, to be replaced by a film of hardened gelatine, the invention of F. C. Froedman, of Dublin. His method consists in mixing bichromate of potash with gelatine, spreading on glass, drying, exposing to light, washing in plain water, then bleaching in a dilute solution of sulphurous acid, again washing, drying and coating with sensitive emulsion. The objection to this film is its extreme limpness when wet, and propensity to assume any shape but a flat one on drying. These were followed in America by the Eastman Company's paper negative, made translucent with castor-oil, and while printing quicker than paper un-oiled, the objectionable grain of the paper marred the result.

Next we have the stripping film of the same company, which up to the present time has proved the best substitute for glass, although in many instances the grain of the paper shows in the finished negative. The objection made by users of this material is the great risk of loss of negatives in the after-process of stripping the exposed film from its paper support and the time occupied in the same. I will read from their instructions as published in *Science of Photography* (Vol. I, pp. 11, 12):

"*Stripping.*—Take as many sheets of glass as you have negatives to strip, each one a size larger than the negatives. Clean, and when dry coat with a rubber solution, which can be either bought already prepared or can be made as follows:

	Oz.
Rubber cement,	1
Benzine,	9

"Place the plates in a rack to dry until 'dead,' which

will take about five minutes. Then flow with the following solution:

"*Plain Collodion.*—

	Oz.	Grs.
Ether,	1	0
Alcohol,	1	0
Gun-cotton,	0	10

"As soon as set wash under the tap until the greasy lines disappear. This is to remove the ether and alcohol. Then place the glass in a tray half-full of cold water, keeping hold of one end with the left hand. Put the negative into the dish face down, press under the water and guide the end nearest the hand holding the glass, so as to clasp the negative with that hand, then raise the *end* of the plate out of the water, thus allowing the water to carry the air from under the negative. Squeegee the negative down, which should be done with light pressure for the first few strokes, and then put it under blotting paper with another sheet of glass over that, and a weight of say eight or ten pounds on it. Allow it to remain under pressure for ten minutes. Now take a tray half filled with warm water at a temperature of about 110° F., or such as will feel comfortable to the hands. The directions sent out with the films, saying to use water at 120° to 140°, I have found to be much too hot.

"Place the glass plate with the negative thereon into the warm water, and, after gently rocking a couple of minutes, try one corner by picking it up with finger-nail or a pin. If it does not start readily do not try to hasten it, for as soon as the water has softened the substratum the paper will come off easily. After the paper is removed raise the plate from the water, wash off the remaining soft gelatine with a tuft of cotton or camel-hair brush dipped in warm water, and set the plate in a rack to cool. Do not change from the warm water to the cold too quickly, as a sudden change of temperature will frill the gelatine.

"After the negative is cool place it in a pan of cold water, holding the fingers under one end of the plate. Take a gelatine skin and slide into the water, smooth side down. Clasp the end of the skin with the hand holding the glass,

and with the other hand press the skin under the water. As soon as the skin is immersed raise the end of the plate slowly, which allows the water to carry the air from between the skin and negative.

"In placing the skin on the negative do not allow it to remain in the water more than thirty seconds or a minute, as the water will soak out the glycerine, and the skin when dry will become brittle. To avoid this tendency it is well to put about ten per cent. of glycerine into the water used for that purpose, or perhaps better yet is a solution of equal parts of wood alcohol and water, which may be kept in a bottle and used from time to time.

"With a wet squeegee go over the skin carefully until all the wrinkles are removed, when allow the negative to dry thoroughly, and flow with plain collodion. As soon as this is dry, cut around the edge and peel from the glass. The rubber adhering can be removed with a tuft of cotton dipped in benzine.

"The negative when completed has a coating of collodion on both sides. This forms a protection against moisture, and gives the negative greater flexibility. I am frequently asked, are the films quick enough for instantaneous work? In reply, I say, most assuredly, yes. A short time ago I made some 8x10 negatives of the New York and Philadelphia Express going at the rate of forty miles an hour. I was on the shadow side, but the negatives were fully timed and showed remarkable detail in the deepest shadows. The train was perfectly sharp, and the driving rod of the engine plain and distinct.

"For interiors, or any work where halation is liable to occur, films are vastly superior to any glass plates, as they do not show halation. I have many negatives giving unquestionable proof of this."

The substance I have the honor to bring to your notice to-night is thin sheet celluloid, manufactured by the Celluloid Manufacturing Company, of Newark, N. J.

It is some three or four years since I first examined into this material, but the manufacturers had not then perfected the finish of it to render it available, and it is only during

this year that it has been produced uniform in thickness and finish, and I am now using at my factory large quantities of sheet celluloid $\frac{1}{100}$ of an inch in thickness, coated with the same emulsion as used on glass, forming flexible negative films, the most complete and perfect substitute for glass I believe yet discovered on which to make negatives and positives, and without a single objection belonging to the substances previously enumerated.

Its weight, as compared with glass, is as follows: Twenty-four 5x8 flexible films weigh seven and one-half ounces, while twenty-four 5x8 glass dry plates weigh from 110 to 120 ounces; and its great merit does not only lie in its lightness, toughness and flexibility, but in that its treatment in development, etc., is precisely that of a glass plate. There is absolutely no after-process required. When the negative is washed it is hung up by a spring-clip to dry, and is then ready to be printed from, and, owing to its thinness, can be printed from the reverse side, if the precaution is taken to use only vertical rays.

Makers of photographic apparatus are already producing light-weight holders to carry these films, and I have no doubt magazine holders will be produced in which thirty to fifty films can be carried and exposed.

I have here an old changing box I used twenty years ago, in which, by a simple device to hold the films and allow of changing from box to holder, I can carry eighteen films.

I have here several negatives made on the films and prints from them, that members can examine at close of meeting.

I will now show on the screen lantern transparencies from film negatives, both contact, and reduced in the camera.

WAYNE JUNCTION,
November 12, 1888.

MEMOIR OF JOSEPH ZENTMAYER.

JOSEPH ZENTMAYER, optician, whose name was known all over the world, and whose death is so sincerely deplored by all his fellow-members of the FRANKLIN INSTITUTE, was born in Mannheim, Baden, in South Germany, in 1826. He received a good education, and learned his trade as an instrument maker. At the termination of his apprenticeship, and after having made his "masterpiece," as is the custom among German mechanics, he travelled throughout Germany, working in the best establishments, and improving himself in the knowledge and use of scientific instruments. He was an ardent republican, and his natural love of liberty led him to take an active part in the agitation that had as its object the establishment of republican institutions in Germany.

He came to America in 1848, in the 24th year of his age, hoping to find a free scope for his notions of freedom in the Western Republic. Between 1848 and 1853, he worked for the best instrument makers in Baltimore, Washington, and in Philadelphia. In 1853, he began to make mathematical instruments in Philadelphia, at Eighth and Chestnut Streets, with but one single lathe. The high character of his work, and the boldness of his conceptions, attracted the attention of the leading scientific men. Among these, the late Dr. Paul B. Goddard was particularly drawn to him, and it was Dr. Goddard who persuaded him to make the first of his large compound microscopes. This early effort was so successful that the Academy of Natural Sciences, and many of the leading physicians who required such instruments, purchased those of his make and discarded the heavy and yet unstable instruments of European manufacture. Once fully embarked in this enterprise it seemed to absorb his whole attention, and many were the improvements that followed each other in rapid succession, not only in the stand of the microscope, but in its objectives. At the present time, there is not a maker of microscopes in the world, who does

not use some of the important inventions of this Philadelphia mechanician. During the war for the Union he furnished most of the microscopes used in the Government hospitals, and he received the highest commendation from all the officers and other authorities for his work.

The Chairman of this Committee made the acquaintance of JOSEPH ZENTMAYER in 1861, and from that time until shortly before his final illness, enjoyed the most intimate and agreeable relations with him, of a social, scientific and business character.

During these many years Mr. ZENTMAYER devised and constructed a great variety of apparatus, which was used in researches or in the illustration of lectures.

The success of these researches and the effective illustration of these lectures, were largely due to the ingenuity and genius of Mr. ZENTMAYER in devising, and to his accuracy and delicacy of workmanship in executing this apparatus. Accounts of the structure and operation of some of these pieces of apparatus will be found in the JOURNAL OF THE FRANKLIN INSTITUTE, 1865, vol. 79, p. 421; 1866, vol. 82, p. 66; 1867, vol. 83, p. 406; 1868, vol. 85, pp. 64, 345, 207, 345. Also in the *Philadelphia Photographer*, 1867, vol. 4, p. 218, p. 231.

In many instances portions of this apparatus had to be ready at short notice, as in the case of some lectures at the Academy of Music, and their completion involved special exertion and prolonged hours of work. In all such cases Mr. ZENTMAYER'S willingness and enthusiasm were of a character which should never be forgotten.

His interest and anxiety for the success of the experiment seemed fully equal to those of the lecturer himself.

In 1865, he invented his photographic lens. The story of his invention of this photographic objective is very interesting. At the time when the Harrison globe lens was attracting attention one member of this committee, Prof. Coleman Sellers, was requested to write a paper for the *American Journal of Science and Arts* on the nature and advantages of the globe lens for the photographic camera. After this was published, its writer consulted Mr. ZENTMAYER about the combination, and he said that it was quite possible to make

a lens of two simple uncorrected concavo-convex or meniscus glasses, made thin and of proper curves, and that such a lens would be chemically correct as to focus, and would also copy a drawing with the marginal lines straight, that is, without any bending of the lines either out or in. He was urged to make a lens of this kind, and finally he did so, sending it to Prof. Sellers to test. That first lens, made as he had proposed, was perfect in its definition, and had all the good qualities he had promised. Most lenses for this kind of work have been the result of a long series of experiments ending in the form adopted. In this case a lens constructed upon a theory proved the correctness of that theory in a most remarkable manner. The Zentmayer lens, which in working is as rapid, if not more so, than other globe lenses in the market, was more simple and filled a want, inasmuch as his system enabled him to make a series of lenses, the front of one lens being used as the back one of another through a series of sizes from the longest focus wanted to the shortest; a set of these lenses, combined as required, meeting all cases that could occur both as to size of plate and proportion of reduction. Mr. ZENTMAYER'S patent for these lenses was not granted at once, but he was obliged to contest his claim before a master, in which examination his claim in regard to priority was fully sustained.

At first Mr. ZENTMAYER objected to patenting this lens, and it was only at the urgent solicitation of Prof. Sellers that he finally consented to do so. Much controversy resulted from the introduction of this objective, but it established Mr. ZENTMAYER'S reputation as a photographic optician of the first rank.

So radically original was the invention embodied in this lens, that the descriptions of it were at first regarded by the practical opticians of Europe as incredible and as American exaggerations, and these ideas led to quite an animated controversy, which may be found in the JOURNAL OF THE FRANKLIN INSTITUTE, 1867, vol. 83, p. 349; also, 1868, vol. 85, p. 153, and more fully in the *Philadelphia Photographer*, 1867, vol. 4, pp. 177, 251, 253, 344; also, 1868, vol. 5, pp. 79, 109.

This lens was first described in the JOURNAL OF THE FRANKLIN INSTITUTE, 1867, vol. 82, p. 63, and reports on its performance by a Committee of the Photographic Society of Philadelphia were published in the *Philadelphia Photographer*, 1867, pp. 44, 151.

When, in 1869, the Chairman of this Committee organized the party to make photographic observations of the total solar eclipse visible in Iowa on the 7th of August, Mr. ZENTMAYER devised and constructed the special photographic lenses which replaced the eye-pieces, and also the drop-shutter attachments for regulating the times of exposure, used with the equatorial telescopes employed on that occasion.

During the preliminary rehearsals and experiments in West Philadelphia, where a temporary observatory was constructed and two of the equatorials were set up, adjusted and operated in making photographs of the sun and moon, Mr. ZENTMAYER was indefatigable in assisting the work, day and night. He also joined the party and went with it to Ottumwa, Ia., where his knowledge and fertility in resources to meet unexpected difficulties contributed largely to the success achieved by that section of the party. All this personal work at Philadelphia and in Iowa was a voluntary, gratuitous, contribution. A description of the above-mentioned apparatus and of the work done with it will be found in the JOURNAL OF THE FRANKLIN INSTITUTE, 1869, vol. 88, pp. 200 to 216, *Les Mondes*, v. 21, p. 228; also in the *Philadelphia Photographer*, 1869, vol. 6, p. 305; also in the *Reports of the Observations of the Total Eclipse of the Sun, August 7th, 1869*, published by authority of the Secretary of the Navy, p. 115.

After the system of screw-threads, known as the "United States," or the "FRANKLIN INSTITUTE, Standard System of Screw-Threads" was introduced, and makers called for instruments to measure the amount of reduction or the width of the flat top and bottom of the threads, a set of thin steel plates ground to an angle of 60° was sent to Mr. ZENTMAYER to have him grind the apex of each to the proper amount. The width of each being given to him in decimals of an

inch to the fourth point. In topping these off he measured the flat by means of a stage and eye-piece micrometer. The correctness of his work was then verified by a member of this Committee, who, taking the finished pieces, measured them on his own microscope in the same manner, setting down the dimensions as found, and afterwards comparing them with what was required, with the result of finding them correct to the fourth place of decimals in each case. This was, in the first place, one of the earliest instances in which the microscope was used in such a mechanical process, and a remarkable example of the facility with which good instruments can be used in such work of precision. The standard gauges, made since by the Brown & Sharpe Manufacturing Company, have all been adjusted to the standard pieces prepared by Mr. ZENTMAYER.

The wonderful comparator, designed by Prof. Rogers, of Boston, and made and used by the Pratt & Whitney Company, of Hartford, Conn., is furnished with microscopes made by Mr. ZENTMAYER, who took great pains to perfect the instruments to be applied to this system of comparing measurements. In all cases where work of great nicety has been required, those who knew Mr. ZENTMAYER'S skill were in the habit of seeking his aid, even in matters not pertaining to optics. The freedom from petty jealousy that marked his character was pleasing to his many friends. No one ever heard him say a harsh word about rivals in trade, even when in the contests, called by some sharpness in trade, he might justly blame some for having acted unfairly. Those who have been for years in the habit of visiting him in his shop, know how kind he always was and how patiently he listened to what they had to say, giving freely from his great store of knowledge, showing his methods and even supplying to those who wished to make any piece of apparatus themselves such parts as he could find suited to their purpose.

Mr. ZENTMAYER'S office in Walnut Street, where he had his lathe close to his counter and near to the cases containing his instruments, was the meeting place of all the scientists of the day. There, at all times, while he was work-

ing, professors and physicians and mechanical engineers would meet and discuss problems in optics or in mechanism; all of these men learning to love the good man who was so simple-minded, and so honest in his dealings. Many times young men, coming to purchase their first microscope, found the great optician advising the purchase of a good working instrument, cheaper than the one they had come to buy, but well fitted to do what would be required of it. No instrument would leave his hands without being personally inspected by him, after he had advanced to the condition of employing workmen to do what at first he did with his own hands. All those who knew Mr. ZENTMAYER felt the influence of his honest, straightforward seeking after truth. It was always a source of pride to him that among the many thousand instruments which he constructed, none ever came back for repair after years of hard usage, except in the case of severe accident, such as would come from a fall, or the like. No amount of work ever did them harm.

The great triumph of his microscope-making was the perfection of the stand, known as that of 1876, which elicited so much favorable comment during our Centennial Exhibition. The invention and practical application of his swinging sub-stage, that enabled him to rotate the illuminating apparatus completely around the object without disturbing its focus, were marked examples of his talent. Others may claim to have made something similar, but none had ever made it so perfect as to be substantially new to all who used it. Now no good microscope is made without this important arrangement of the stand. The binocular microscope, under his hands, became more useful than ever before. It was not until he had perfected this form that he was willing to sell a binocular instrument. He knew the good that was to be obtained by means of the binocular principle, but he was unwilling to make one for sale until at last he had surmounted all the objections he saw in the system, and had made so perfect an instrument that he did not fear to attach his name and reputation to it.

In the construction of his simple form of sliding stage others may claim the prior invention of the principle in a

crude form, but it is very certain that to Mr. ZENTMAYER, and to him alone, is due the credit of making this simple device as perfect as the most costly compound stage, so far as comfort of working and certainty of motion is concerned. To suggest is one thing, but to perfect into an efficient instrument is perhaps the most important after all.

Mr. ZENTMAYER was not willing to push himself forward, but when he at last was persuaded to lecture on optics at the FRANKLIN INSTITUTE, his lecture proved to be as well worthy of the man as all his mechanical work. It stands to-day as an important addition to the literature of optics.

Mr. ZENTMAYER'S musical education, as well as his artistic, made him an appreciative critic, and among his countrymen his poetry is valued. He was so loving and so kind, so winning in his ways, that all who came in contact with him were attracted towards him, and when his last illness came, warning them that the mind they had valued so highly was losing its great strength, they mourned his death long before the actual dissolution of his body.

After leaving Philadelphia, in 1870, the Chairman of this Committee saw, of course, less of Mr. ZENTMAYER, although he had the pleasure of having him stay at his house in Hoboken on several occasions, once in company with the German scientist H. Vogel, and on another occasion with the eminent investigator and constructor of acoustic instruments Rudolph Kœnig; the Chairman, however, always kept up a correspondence with Mr. ZENTMAYER and sought his assistance whenever he had need of any instrument involving especially fine and accurate workmanship.

No words that he could use would be too strong to express what he knows of Mr. ZENTMAYER personally as a man of high intellectual acquirements, refined tastes, pure morality and a sincere amiability which enabled him to think and speak only kindly even of those who had not treated him well, and which unspeakably endeared him to all who enjoyed the privilege of his friendship.

The illness that at last resulted in the death of Mr. ZENTMAYER came on very slowly, and fortunately only after he had instructed his sons in the processes that had made his work

so celebrated. Those sons have had charge for a number of years of the construction of the instruments which have given such great satisfaction to all who have used them. To members of this Committee the father confided his system of education of his children, and to them he explained how thoroughly he had informed them of the minutiæ of his operations, that they might worthily carry on a business of which he was so proud. Mr. ZENTMAYER would never do any work slightingly. What was to be done must be done well, his constant effort being to improve his methods as well as improve the construction of his instruments.

His inventions, that have carried the name of ZENTMAYER to all parts of the civilized globe, were not made rapidly, as a rule. He pondered over all his improvements for a long time, and they all show deep thought. Those who knew him best remember the look of deep thought impressed on his speaking face when they called and found him alone with his big dark-colored working microscope before him. They knew he was being interrupted in work that would soon add some new thing to his list of accessories, or in the perfection of some instrument. With his life has gone the spirit of a pure-minded and upright man, a good citizen, a lover of liberty and a lover of truth. To the family he leaves behind him, if he has not been able to give them much worldly wealth, he certainly has given a worthy example for them to follow.

As a writer, Mr. ZENTMAYER was not prolific, preferring to express his ideas verbally to his friends, rather than to put them on paper for publication. We find, however, the following articles, which were his work, in the JOURNAL OF THE FRANKLIN INSTITUTE:

On a Mechanical Finger for Use in Mounting Diatoms under the Microscope, 1870, vol. 89, p. 334.

On an Erecting Prism, for Use in the Microscope, 1872, vol. 93, p. 375. A Lecture on Lenses, 1876, vol. 101, pp. 336 and 421.

On Improvements in Microscopes, 1877, vol. 104, p. 49.

Also in the *Philadelphia Photographer*, 1867, vol. 4, p. 251, we find an article entitled "Refraction without Dispersion,

and some Reflections," in which he takes a hand in the controversy about his photographic lens, with marked ability.

Mr. ZENTMAYER was elected a member of the American Philosophical Society in 1873, and of the FRANKLIN INSTITUTE in 1865. He received the Elliott Cresson Medal for improvements in microscopes in 1875.

HENRY MORTON,
COLEMAN SELLERS.

CORRESPONDENCE.

PHOTOGRAPHS OF LIGHTNING.

The Secretary, FRANKLIN INSTITUTE.

DEAR SIR:—In view of the fact that the Royal Meteorological Society of London, England, has recently published a pamphlet in which the Thunderstorm Committee state that after twelve months investigation it has been concluded that lightning never occurs in the zigzag form so commonly seen in pictures, I would like to call your attention to the fact that for many years the writer has held this view of the matter, and in the summer of 1882, a series of photographic experiments were made, the object being to prove the wavy line theory of lightning by means of the camera, which has been carried on since that time with successful results.

At the September meeting of the INSTITUTE, 1885, I forwarded to you a communication, together with a lantern slide showing a photograph of lightning, and drawing your attention to the fact of the wavy line character of the discharge, and its identity with the spark of an electrical machine. This photograph, with my letter in relation to the wavy line theory, was reproduced in the *Scientific American*, of September 5, 1885.

Since that time I have sent you two other photographs of lightning, and now I would be much obliged if you would exhibit at the next meeting the accompanying lantern slides in the following order:

No. 1. Photograph of lightning occurring between two clouds; taken in September, 1882.

No. 2. Photograph of lightning extending from zenith to horizon; clearly exhibiting the wavy line character of the discharge. Taken at 10.30 P. M., August 1, 1885.

No. 3. Photograph of a horizontal discharge of lightning with numerous branches, in each of which the wavy line is maintained. Obtained June 1, 1887.

No. 4. Vertical streak of lightning, which is very remarkable, on account of its lower extremity appearing to be in a molten condition. This was taken May 29, 1888.

The object of this letter is to place myself on record as being the first

practically to prove, by means of the camera, the wavy line theory of lightning, and its identity with a frictional machine spark, the results of which were exhibited in the lecture hall of the FRANKLIN INSTITUTE, in September, 1885.

The future developments in this line of photographic research are so promising, that it might become of interest some day to trace its origin.

Very respectfully yours,

WM. N. JENNINGS.

1302 BUTLER STREET, PHILADELPHIA, *October 16, 1888.*

BOOK NOTICES.

DARWINISM.—A BRIEF ACCOUNT OF THE DARWINIAN THEORY OF THE ORIGIN OF SPECIES. By David Starr Jordan, Ph.D., M.D. Chicago: A. B. Gehman & Co. 1888.

To make the "Darwinian" theory of the origin of species clear to the mind of the general reader is anything but an easy task, not so much in the understanding of the theory itself as in the vast amount of prejudice to be overcome. Although this little book does not, by far, contain all that could be desired upon the subject, the author has, nevertheless, produced a very readable and instructive dissertation upon the facts and theories of the origin of species. His explanation of the diversity of species is made very simple as he puts it. "When I compare my arm with that of my neighbor, I find differences in size and proportions. But these are superficial, and there is the underlying correspondence of each bone and muscle, each nerve fibre, artery and vein. When I compare my arm with the foreleg of a dog, I find more striking differences, for the dog's station in life is quite unlike my own, and he uses his arm for different purposes. When I compare my arm with the wing of a bird, or the pectoral fin of a fish, the results are similar. Though the differences in each succeeding case become more and more striking, and resemblances less easy to trace, yet the same resemblances exist, and a closer study shows that these resemblances far outweigh the differences." One of the strongest points the author makes are his few lines upon "special creation." "If each of the half million of species of animals and plants which now live, and each of the millions of kinds which have become extinct has been the subject of a 'special creation,' then 'special creation' is but a name given in our ignorance to the law by which species are produced." We feel sure that every true scientist will, at least in some degree, echo the author's thoughts in the following remarks upon the subject of the Darwinian theories and Christian religion. "Our objections to recognizing our kinship with the lower forms—if we have any such objections—rest on reasons outside the domain of knowledge. They do not rest on religious grounds. Those who think so deceive themselves. The question of the Christian religion is not in any sense concerned in this discussion. The Darwinian theory deals only with the methods of creation, the 'secondary causes' in the providence of God. 'Theology and science,' says Darwin, 'should each run its own

course. * * * I am not responsible if their meeting point still be far off.'"

To thoroughly appreciate and enjoy this little work, the reader should possess a pretty general knowledge of geology and its kindred sciences, otherwise the author's meaning will not always be clear. F. L. G.

ACCIDENTS AND EMERGENCIES; A MANUAL OF THE TREATMENT OF SURGICAL AND OTHER INJURIES IN THE ABSENCE OF A PHYSICIAN. By Charles W. Dulles, M.D. Third edition, 12 mo. Philadelphia: P. Blakiston, Son & Co.

This volume of 120 pages presents, in condensed form, the efforts proper to be made for resuscitating drowned persons, relief from sudden entrance of foreign bodies in the eye, nose and ear; action to be taken in regard to fits, convulsions, injuries to the brain, effects of heat and cold, wounds, fractures, dislocations, hemorrhages, railroad and machinery accidents, poisons, domestic emergencies, etc. There are illustrations of proper positions of the body and separate limbs under treatment, also directions for prompt bandaging; and the whole concludes with a list of supplies proper to be kept on hand for such use. The author makes the following sensible suggestion: "Let the volume be read through, at least once, as carefully and as studiously as possible, so that the reader may make the acquaintance of its suggestions; and then let it be kept in some handy place, where it can be referred to immediately when emergency arises."

The volume has at front a general table of contents, and at the end a detailed index, and the whole appears to be what it professes, and worthy of wide circulation. Though much in it is not new, the form of presentation and the grouping of efforts add value to what, though often heard, might be forgotten in the excitement of an emergency. N.

PLATE GIRDER CONSTRUCTION. By Isami Hiroi. New York: Van Nostrand. 1888.

The importance of the use of plate girders in construction cannot be overestimated, especially as the last few years have shown that, with scientific designing, for economy of material and strength, they can replace with great advantage the open truss for a longer span than is generally used.

With the exception of an occasional chapter in text-books on bridges and a few paragraphs in hand-books, but little information on this subject exists. Prof. Hiroi however, in his work, has gone into the subject very thoroughly; treating of the theory exhaustively; and deducing a number of important formulæ, which can readily be applied by the practical designer and draughtsman.

To illustrate:—A plate girder, fifty feet in length is taken, and rules are given, gleaned from the best practice, for assuming an effective depth. The calculations are then made for the web and flange stresses, for both dead and live loads; and with the data thus obtained, the girder is designed with the proper allowances for riveting, splicing, stiffening, etc.

The method of making estimates for the cost is also shown, and in a summary is given some very valuable practical information concerning the details.

In the discussion of the theory, important principles and formulæ are in many cases given without sufficient explanation and demonstration, requiring for their intelligent comprehension a more thorough knowledge of advanced mechanics and bridge stresses than is possessed by the average reader. The theoretical investigation of the web stresses is somewhat novel, but is very thorough and logical. In the deduction of the flange stresses, both graphical and analytical methods are used. As the author implies a preference for the former, a more elaborate explanation of method and detail would greatly lessen the labor of a beginner. For obtaining maximum flange stresses due to live loads, by making the polar distance equal to the assumed effective depth of the girder, the calculations would have been shortened somewhat, as the desired results would then have been obtained directly.

Although the results for obtaining the effective depths, for riveting, splicing, stiffening and flange widths, vary somewhat, and in some cases considerably, from those given by a number of bridge companies, yet the context evinces such a conscientious and thorough investigation of the theory, as well as so complete a practical knowledge, that the work cannot fail to prove of value to the designer, constructor and inspector, as well as to the teacher who desires to impart its principles and suggestions to his classes.

The entire work is embraced in a duodecimo of ninety-four pages, published by D. Van Nostrand, New York City, at a price which makes it a very desirable investment.

B. F.

THE GEOLOGICAL EVIDENCES OF EVOLUTION. By Angelo Heilprin. Philadelphia. Published by the Author. Academy of Natural Sciences. 1888.

This book certainly supplies a pressing need and it especially recommends itself to educated and thinking persons who have not had the advantages of any scientific training. It is, however, to be regretted that the book has been so much condensed; indeed, this has been carried so far that in some places the language is somewhat vague, and the successive evolutional steps have not been sufficiently simplified. One cannot read Prof. Heilprin's writings or hear his lectures without wishing they were longer, and if this little book possesses any serious fault it is in being altogether too concise.

F. L. G.

SCIENTIFIC NOTES AND COMMENTS.

ENGINEERING.

EFFICIENCY OF STEAM AT HIGH PRESSURES.—Mr. A. W. Beauman, in a paper read at the last meeting of the Mechanical Section of the British Association, shows that the Carnot theorem for the efficiency of a heat engine is limited in its application to steam-engine calculations of efficiency, and that high-pressure steam must theoretically, as well as practically, be more efficient than low-pressure steam. For some time it has been evident that the behavior of steam in a steam-engine cylinder cannot be interpreted by laws that are true for a permanent gas, and that the actual efficiency of its action is not proportional to the range of temperature used in the cylinder. It has, on the contrary, become evident that the practical efficiency is more nearly inversely proportional to the range of temperature in the cylinder; and, moreover, it has become increasingly evident that the efficiency of the actual steam engine cannot be usefully measured by any standard based on the Carnot theory of the perfect engine, as expressed by the relation

$$E = \frac{T - T_1}{T}.$$

Modern practice has amply proved that the real efficiency of the steam engine has only been increased as the special character of the working fluid has been studied and provided for. The Carnot theorem ignores the nature of the working fluid, and the endeavor to realize with steam the conditions of a Carnot engine has led to delay in the development of the steam engine. Formerly it was assumed, chiefly as a deduction from Carnot's theorem, that there could be little gain as a result of the use of high-pressure steam, because the thermal value increased so slowly with the increase in pressure. Upon the same grounds it is now generally held that the present state of our knowledge indicates that a pressure of about 200 pounds will give results equal to those which are possible with any higher pressure. This argument is strictly in accord with the Carnot function, and it is this argument which the writer proposes to show is not necessarily a true one.

The efficiency of an engine working between fifty pounds pressure and 100° F., according to Carnot's theorem, is ·242. A pressure of 100 pounds gives ·290, 150 pounds gives ·315, and 300 pounds gives ·362. Thus, according to the theorem, the gain attending the use of pressures above 150 pounds could not be sufficient to counterbalance the practical disadvantages incurred. Experience has proved that this is the reverse of the truth. Every increase in pressure has secured an increase in actual efficiency which has been far more than is necessary to cover the increased cost of obtaining it. The rate of increase has been double that which the Carnot theorem indicates, and it has been amply shown that the engines made for and supplied with steam at a high pressure work under conditions which are much more nearly those

required for maximum efficiency than do those engines which work with lower pressures.

By raising the steam pressure from sixty-five to 150 pounds, the efficiency ought to be increased by twenty-one per cent., or a saving of seventeen per cent. ought to be made. As a matter of fact a saving of from twenty to more than thirty per cent. has been achieved. It is clear, then, that the high-pressure engine is remarkably efficient, or that the low-pressure simple engine is remarkably inefficient.

Now, as the total heat of a volume of steam is within a few units as great after expansion as before it, and nearly all the fall in the quantity of heat takes place when the steam leaves the steam-engine cylinder, it is desirable to examine the relative conditions of expansion through a given range of pressure before exhaust occurs, as, for instance, 100 to 50 pounds, or 200 to 150 pounds. If a pound of steam at 350 pounds pressure expands to a pressure of 300 pounds, it will have fallen in temperature 15°, doing 10,372 foot-pounds of work. The work done by expansion per degree fall of temperature is 691 foot-pounds. Again, one pound of steam at 300 pounds expanding to 250 pounds falls in temperature 16°; the work done is 12,235 foot-pounds, or 765 foot-pounds per degree fall in temperature. Between steam at 100 pounds and fifty pounds there is a difference of 46·8°, and the work represented by the expansion of one pound of steam from one to the other is 49,280 foot-pounds or 1,053 foot-pounds per degree. There is thus per degree fall in temperature of steam expanding from 350 pounds and from 100 pounds, respectively, a difference of $1,053 - 691 = 362$ foot-pounds.

It will be seen, therefore, that if heat disappears in proportion to work done, that the low-pressure engine cylinder for a given range of pressure must require more heat, either from a steam jacket or from steam liquefied on entering the cylinder during the admission part of the stroke, than the high-pressure cylinder.

The conclusions to which the author is at present inclined, although the paper is intended only as a preliminary consideration of the subject, are: (1) That the work done with steam in a steam-engine cylinder is not proportional to the range in temperature; (2) that steam pressures much above 200 pounds on the square inch may be used with advantage; (3) that a small range of pressure should be used in each cylinder; (4) that the number of cylinders should be as large as mechanical considerations will allow; (5) that the economy obtained by multiple stage-expansion engines, as compared with single stage expansion, is due to the small difference of temperature in a cylinder on the opposite sides of its piston; to the opportunity which the protracted working history of the steam gives, for the utilizable re-evaporation of the steam which is condensed in providing the difference, between the heat represented by work done during expansion, and the heat which corresponds to the change of volume, and to the large quantity of work done during expansion at high pressure per unit of difference in the heat required to raise from a high to a higher pressure. H. W. S.

THE READING RAILROAD TERMINAL.—It is proposed by a syndicate of

public-spirited citizens to increase the facilities of travel to the country and suburban districts, tributary to the Reading Railroad system, by extending the line on an elevated arcade, similar to that of the Pennsylvania Company. The right of way has been purchased in fee, and the Company now awaits the action of City Councils, before beginning the construction of the proposed station at Twelfth and Market Streets. This project has disturbed the equanimity of the peaceful and quiet-loving community of Friends residing on Arch Street, which the line crosses, and has also excited the opposition of other interests, which, it is supposed, may be injured by the new line, so that we find history repeating itself, and the battle for progress being contested as warmly as ever.

The trite maxim of "the greatest good to the greatest number," as well as the increased revenue due to increased values, the great saving of time to the thousands whose homes must, of necessity, be remote from business and school, the four-fold greater area which becomes available by doubling the velocity of travel, are either overlooked, unknown, or overclouded by the personal interests which may destroy all patriotism and public spirit, and which would, if possible, reduce Philadelphia to the provincial "greene country towne," designed by its founders. This line will open up and render much more accessible over thirty-one miles of railroad within the city limits, developing one of the most beautiful and healthful sections for residences to be found in the vicinity of the city.

As to the method adopted by the Terminal Company, of securing its object by the purchase of property and the construction of an elevated way, it appears to be a question of relative cost and damages, which the Company have decided in favor of this plan, for this route. We think the interests of the city would have been better served had the Company joined issue with the recently chartered underground company, and thus have connected its lines with every part of the city, instead of with a single point, and at less expense.

That the expense would be less is shown by the fact that the estimate for elevating the trackways of the Reading Railroad system for a distance of five and five-sixteenths ($5\frac{5}{16}$) miles, so as to give the Company the same facilities as at present, is placed at $12,750,000, or about $2,400,000 per mile. This includes terminals, but excludes the proposed extension from Ninth and Green to Twelfth and Market, and the purchase of right of way. The proposed underground way was estimated at about $1,056,000 per mile. Z.

CHEMISTRY.

ANIMAL CHLOROPHYL.—In the *Journal of Physiology*, for March, 1888, Prof. C. A. MacMunn reports studies on the chromatology of British sponges. The value of the paper to the general reader is the recorded similarity of the lipochromes, floridines, and uranidines of sea-water sponges to the chlorophyl of plants.

Out of twelve species of sponge examined by Prof. MacMunn, ten contained chlorophyl; adding to these seven sponges studied by Krukenberg,

we have seventeen sponges proven to contain chlorophyl by means of spectroscopic examination and chemical reagents. With regard to this chlorophyl, our author says: "I have no hesitation in saying that no difference worth mentioning was observed between it and vegetable chlorophyl." Chemical reactions proved it to be of purely animal origin; marine algæ are often to be found growing into the sponge substance, but great care was taken in these experiments to select portions in which, even when examined microscopically, with powers up to 1,250 diameters, no vegetable growth appeared. Prof. MacMunn does not think it necessary that the co-existence of starch with chlorophyl should be demonstrated in order to prove the presence of animal chlorophyl. Even in plants it is not always possible directly to observe starch as the product of assimilation in the chlorophyl grains; in such cases the starch produced in the chlorophyl may be at once transformed into fat.

If chlorophyl is present in sponges, the question arises, of what use is it to them? It cannot be of use for mere surface coloration, as its tint is, in most cases, disguised by yellow, red, or other color, and it must, therefore, be of use, either for purposes of assimilation, as in plants, or for respiration. Since chlorophyl is usually much more apparent in the external parts of the sponge, it is likely that it has something to do with the absorption of light rays. Prof. MacMunn "cannot help thinking that the very peculiar absorption spectrum of chlorophyl indicates a property which is peculiar to it, and which enables it to sift out rays of a certain wave-length to be utilized in the synthesis of the carbohydrates." The latest researches suggest that chlorophyl may be a respiratory pigment, and all recent botanical knowledge tends to explain its function as that of a carbonic acid carrier. It may primarily remove the waste CO_2, and afterwards, by the influence of light rays, build up from CO_2 and from water, some substances, such as starch, glycogen, sugar, or fat, which are of direct service to the animal or plant. If this is its function, chlorophyl may be of great use in the constructive metabolism of animals. R. L. B.

A New Method of Preparing Silicon.—H. W. Warren (*Chem. News*, **57**, 54) suspends small bars of ferro-silicon immersed in dilute sulphuric acid from the positive pole of a battery, and resting upon a platinum plate that forms the negative pole. After solution of the iron, the residue consists of graphite, silica and amorphous silicon; this residue is heated to redness in carbon dioxide, and then to bright redness in a closed iron tube with zinc. The silicon is dissolved by the zinc, and is obtained in crystals when the zinc is treated with hydrochloric acid. If aluminium be used instead of zinc, and the temperature raised to whiteness, graphitoidal silicon is obtained.

W. H. G.

On the Preparation and Properties of Nitrogen Chloride.—Victor Meyer has recently described (*Berl. Ber.*, **21**, 26) a method for the demonstration of the explosive properties of nitrogen chloride as a lecture experiment, the compound being prepared in a double-walled case of thick glass. Still more recently, Dr. Ludwig Gattemann (*loc. cit.* 751) has been

able, by following Meyer's method of operation and adopting special precautions for personal protection, to investigate more closely than had ever before been attempted, the properties of this unstable substance. Before these experiments no effort had been made to analyze nitrogen chloride, analysis having been limited to a determination of the ratio between the chlorine and nitrogen.

The compound was prepared by the reaction of chlorine and solution of ammonium chloride, and it is to be noticed that no oily drops appeared until more than half the chlorine (in a flask about one litre) had been absorbed. Very small globules then appeared, formed a film over the surface, and the film broke up into large drops, some of which sank, but were carried up and down in the liquid by a slow disengagement of nitrogen, owing to gradual decomposition. The drops were shaken down into a small lead capsule under the mouth of the flask, this capsule itself being placed in a large lead capsule that at first contained the solution of ammonium chloride. The small dish, with its contents, was carefully removed from the larger one, and the liquid poured through a funnel into a thin-walled separating funnel made for the purpose. The success of this operation showed that the explosive properties of nitrogen chloride have been exaggerated, for the liquid fell through more than two decimetres, experiencing considerable friction. The solution of ammonium chloride was removed by a pipette, and the oily liquid repeatedly shaken with water until the washings would give no chlorine reaction. The wash water must not be drawn into the caoutchouc bulb used to suck it up into the pipette, nor must it be allowed to come in contact with organic matter on running from the pipette, for it always contains small suspended globules of nitrogen chloride. Dissolved chlorine was removed by repeatedly blowing air through the liquid by the aid of a glass tube, so that the oily liquid was broken up into small drops and disseminated in the water. The nitrogen chloride never exploded in this operation.

It was then run off into a small glass flask, and this part of the operation is the most dangerous, on account of the friction of the stop-cock; in several experiments explosions took place at this stage. After the separation a small flask must at once be put under the end of the funnel that no drops may fall on the table. The nitrogen chloride was now dried by shaking with a small piece of fused calcium chloride free from dust, poured into a weighed cylindrical flask containing about one c.c. and provided with a not quite air-tight glass stopper. It was then weighed, the balance being placed in the glass case. The last-described operations are the most unpleasant, on account of the extremely irritating action of the vapor of nitrogen chloride on the eyes and mucous membranes.

The opened flask and its stopper were then quickly dropped into a bottle containing water, and the nitrogen chloride decomposed by ammonia which was gradually added. The chlorine was estimated as silver chloride.

The results showed that the product of the action of chlorine on ammonium chloride is not a uniform substance, but a varying mixture of several chlorinated ammonias; the longer the time of action of chlorine the more nitrogen trichloride is formed.

Pure *nitrogen trichloride* was prepared by passing chlorine through the product in the separating funnel after the ammonium chloride had been washed out, the drying and analysis being conducted as before.

Nitrogen chloride is exploded by the action of direct sunlight, and was in one case exploded by the light of burning magnesium. The author met with no explosions that could not be accounted for, and believes that previously reported spontaneous explosions of nitrogen chloride were occasioned by light.

The action of heat was studied by heating about half a gramme of the substance in a thin-walled tube immersed in fluid vaselin, the phenomena being observed from a distance of about five m. by the aid of a telescope. Up to 90°, no change occurred, but at 95° the apparatus was entirely destroyed by a violent explosion.

The author has prepared nitrogen chloride for these experiments about thirty times, and on account of the irritating nature of the vapors and the nervous strain of prolonged experiments where an explosion may occur at any moment, and which demand an extraordinary number of precautions, has postponed further work for a short time, hoping to eventually study the chemical properties of this interesting compound. W. H. G.

Composition of Bronze of Japanese Magic Mirrors.—Specimens of metal from three of the so-called Japanese mirrors, which came into the writer's possession, were examined under the direction of Dr. Geo. A. Koenig, of the University of Pennsylvania. The results are given in appended tabulation.

The composition of these bronzes varies to such an extent that it is manifest that they are not made according to any fixed formula. Each metal-worker evidently using his own recipe.

	No. 1. *J. E. Hawkins.*	*No. 2.* *M. H. Pugh.*	*No. 3.* *Geo. A. Koenig.*	
Cu =	79·618	72·64	89·94	
Pb =	12·941	14·72	7·25	
Sn =	4·37 (by diff.)	8·52	. . .	
As =	2·531	2·94	3·03	
S =	. . .	. . .	0·22	
Fe =	0·540	0·12	0·23	
	100·000	98·93	99·97	W.

MISCELLANEOUS.

The Universal Exposition of 1889, at Paris, promises to be one of the largest and most successful of the world's fairs held in recent years. Elaborate arrangements for the reception and display of the exhibits are well under way, and unusual facilities, both for the transportation of goods from this country and their care, are assured. The French government extended a formal invitation to the United States to take part in the Exposition. The invitation was accepted by a joint resolution of the Senate and House of Representatives, and the governors of the several states and territories were requested to invite the people to assist in the proper representation of the

products of American industry and of the natural resources of the country. The President was directed to appoint a commissioner-general and an assistant commissioner-general to make all of the arrangements for exhibits and represent the Government at the Exposition. He was also directed to appoint nine scientific experts as assistants to the Commission, each to be assigned to one of the nine groups into which the exhibits will be divided. Provision was made for the salaries of the commissioners and the necessary assistants, and the sum of $250,000 was appropriated to be used under the direction of the Secretary of State to defray all expenses. The action of Congress was approved May 10th, and the President has appointed General William B. Franklin, Commissioner-General, and Mr. Somerville P. Tuck, Assistant Commissioner-General.

The commissioners have established their headquarters in the Mills Building, New York, and are busily engaged receiving applications and perfecting the details for a complete representation. The Exposition will open May 5th and close October 31, 1889, and there will be no charge for space occupied by exhibitors. The Commission will forward and return all articles received free of freight charges.

Goods of exhibitors who are unable to go to Paris or send representatives will be cared for free of all expense, except that of unpacking and repacking. There will be no duties to pay except on goods that are sold or consumed. The French regulations state that all objects exhibited will be protected against piracy of inventions or designs.

The exhibition is to be divided into nine groups or departments as follows:

(1) Works of art.
(2) Education and processes used therein.
(3) Plain and decorative house furniture.
(4) Textile fabrics.
(5) The raw and manufactured products of mining, forestry, chemistry, etc.
(6) Apparatus and methods of mechanical industries.
(7) Food products.
(8) Agriculture, vine culture and fish culture.
(9) Horticulture.

The French government has appropriated 43,000,000 francs toward the expense of the Exposition. An advisory commission, consisting of 300 members, and styled the "Grand Council of the World's Exhibition of 1889," has been appointed. The Minister of Commerce and Manufactures acts as president of this council and also as commissioner-general of the Exhibition. The grand council is divided into twenty-two advisory committees, who have charge of the different departments and the management of the Exposition.

The buildings for the Exposition are now nearly completed. They occupy the Champ-de-Mars and the Trocadero Palace and Park on the banks of the Seine. In the park, at the entrance to the exhibition on the Champ-de-Mars, the wonderful Eiffel Tower is now in course of erection. It is to be entirely

of iron and 1,000 feet in height. Its object is to show the triumph of modern engineering skill. It will be furnished with an elevator of American manufacture. On the right of the tower is the Palace of Liberal Arts, and on the left the fine Palace of Fine Arts. Large gardens occupy the centre of the square, and at the back is the main building, or the Gallery of Machines as it is called. The Esplanade des Invalides is reserved for the products of the French colonies. The buildings are magnificent structures of glass and iron, lighted by electricity, and fitted with every modern convenience.

It is expected that the total number of exhibitors from all countries will reach 30,000; it is estimated that 12,000,000 persons will enter the grounds and buildings. Some idea of the magnitude of the exhibition may be gained from the fact that the total area of buildings and enclosed grounds, which is to be lighted by electricity, is 3,000,000 square feet. The space allotted to the United States is about 75,000 square feet. An exhibit from this country fully equal to that of 1878 is expected, and it is hoped that it will be much larger. There are numerous lines of industry that need new markets for their goods, and this exhibition will afford them an opportunity for foreign display.

All of the European countries, except Germany, take an interest in the Exposition, and will make displays. The South American republics and Mexico will also take a particularly active part, as well as Japan.

The usual awards of medals and diplomas will be made, but the details as to this have not yet been determined. W.

PRODUCTION OF INDIGO IN CHINA (*Jour. Soc. Arts, May 4, 1888*).—According to the report of British Consul Jones, of Chin Kiang, the indigo plant is cultivated as part of the crop of every farmer in that province, and after its manufacture into the dye is employed by his family for dyeing the cotton goods used for the clothing of his people. That which is not so consumed is put upon the market for sale and exportation.

As in the cultivation of rice, the seed of the indigo plant is sown in patches of ground, and as thickly as possible. In a month, when the plants are several inches high, they are transplanted into a large piece of ground, and in rows about eighteen inches apart. When they reach a height of about two feet, and the leaves have assumed a dark, rich blue color, they are cut to the ground, and gathered for the manufacturing process.

From the roots, when the plants are cut down, another growth springs up, and two crops are obtained in the year. In every farm there are a dozen or more large earthen jars or kongs, with the capacity of a barrel, which are used for the manufacture of indigo. Those who engage extensively in the manufacture have a large brick-lined tank built in the ground, six or eight feet in depth, and of a diameter of ten or fifteen feet, with a capacity of many hundred gallons. The plants are placed in these receptacles, and covered with clear, fresh water, where they are allowed to lie for several days till the indican is decomposed by fermentation. This process is aided by the addition of a little slaked lime and frequent stirring, when the indigo is precipitated in the form of a dark blue sediment, which, when dried, forms the indigo of commerce. H. T.

GIFTS TO THE LIBRARY OF THE FRANKLIN INSTITUTE.

Argentine Republic. Message of the President on opening the session of the Argentine Congress. From the President.

Armstrong on Steam-Engine Boilers. From Mr. Enoch Lewis.

Ball Electric Light Company. Announcement, etc. From the Company.

Bureau of Statistics. Quarterly Report of the Chief, No. 4. 1887–1888. From the Bureau.

Commissioner of Labor. United States. Third Annual Report, 1887. From the Commissioner.

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Cooper, J. H. One Rule for All. (Reprint Manufacturer and Builder.) From the Author.

Department of Agriculture. Periodical Bulletin. Vol. 1, No. 4. Report of the Statistician, No. 56. From the Department.

Diagram showing evaporative Power of American Coals as determined in the years 1878 to 1882, at the Quartermaster's Department, Washington. From Gen. M. C. Meigs.

Holmes, G. Science of voice Production and voice Preservation. From Dr. Isaac Norris.

Hydrographic Office. Pilot Chart of the North Atlantic Ocean. November, 1888. From the Office.

Journal of Analytical Chemistry. Vol. 1. 1887. From the Editors.

Lightning Flash. Two photographs. From Mr. W. N. Jennings.

Massachusetts State Agricultural Experiment Station. Bulletin No. 31. From the Station.

Meteorological Office. London. Weekly Weather Report, May 14th to September 24th. From the Office.

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Senate Miscellaneous Documents. Vols. 2, 3, 7 and 8.
House Executive Documents. Vols. 13, 18, 22, 24, 29, 32, 34 and 37.
House Miscellaneous Documents. Vols. 8, 10, 11, 14, 18, 19, 21 and 26.
From the Department of the Interior.

Quimby, W. Ophir. From the Author.

Seafert System of Generating Electrical Energy.
From William Seafert & Co.

Semaphore Signals. Two photographs. From Prof. C. H. Koyl.

Schley, Winfield S. Report of. Commanding the Greely Relief Expedition.
From Secretary of the Navy.

Signal Office U. S. Daily International Chart. September, 1887. Summary and Review. September, 1887. From the Office.

Smiley, Charles W. Altruism Considered Economically.
From the Author.

Taylor, Frank H. Autumn Leaves upon the Lehigh.
From Mr. S. H. Needles.

United States Geological Survey. Twenty United States Atlas Sheets.
From the Survey.

University of Pennsylvania. The Muybridge Work.
From the University.

Franklin Institute.

[*Proceedings of the Stated Meeting, held Wednesday, November 21, 1888.*]

HALL OF THE INSTITUTE, PHILADELPHIA, November 21, 1888.

Mr. CHAS. BULLOCK, Vice-President, in the Chair.

Present, 135 members and thirty-three visitors.

Additions to membership since previous meeting, seventeen.

Mr. SAMUEL SARTAIN, Treasurer, reported the gift of an additional $5,000 from Mrs. CLARA JESSUP BLOOMFIELD MOORE, to the BLOOMFIELD H. MOORE trust fund for the endowment of the Library. The trust was accepted and the thanks of the INSTITUTE were ordered to be transmitted to the giver.

The following papers were read in the order named below, viz:

"A Substitute for Glass as a Support for Gelatine Bromide of Silver in Photography," by JOHN CARBUTT.

"The Parabolic Semaphore; an Improved Railroad Signal," by Prof. C. HERSCHEL KOYL.

"Heliochromy." Further contributions to Photography in Natural Colors, by FRED. E. IVES.

The papers were referred to the Committee on Publications.

On Mr. G. M. ELDRIDGE'S motion, the subject of Prof. KOYL'S paper was referred to the Committee on Science and the Arts, for further investigation.

The Secretary presented his usual monthly report, in the course of which he exhibited an elevation and plans of a new building for the INSTITUTE, designed by Jos. M. WILSON, architect, and President of the INSTITUTE.

Adjourned.

WM. H. WAHL, *Secretary.*

PENNSYLVANIA STATE WEATHER SERVICE.

MONTHLY WEATHER REVIEW.

FOR MAY, 1888.

Prepared under the Direction of the Committee on Meteorology of the FRANKLIN INSTITUTE.

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, May 31, 1888.

TEMPERATURE.

The mean temperature of May, 1888, 57°·6, is about 3° less than the May average. This departure, together with the deficiency that existed at the beginning of the month, and the unusual number of rainy and cloudy days and cold nights, has increased the lateness of the season, and the growth of vegetation is correspondingly backward.

The lowest reported temperatures were Coudersport, 23°·5; Drifton, 24°; Dyberry, 24°, and Phillipsburg, 24°. The highest were Phillipsburg, 91°; Johnstown, 90°; Coatesville, 89°; York, 87°·5; Kutztown, 87°·3; Altoona and Pottstown, 87°. The cold periods of the month were on the 3d and 17th, and the warmest on the 28th and 29th. A killing frost occurred on the 17th, which was general throughout the State. Considerable damage was done by it to fruit and tender vegetables.

ATMOSPHERIC PRESSURE.

The barometer was normal and ranged from 30·380 to 29·590 at Erie. The highest pressures occurred on the 6th, 7th, 8th and 20th; and the lowest on the 1st and 12th.

PRECIPITATION.

Rains were of almost daily occurrence, the 6th, 20th, 21st and 22d being the exceptions. The total average, 4·24 inches, gives an excess of about 1·10 inches. The central part of the State received the greater portion. Huntingdon reports 8·41 inches; Girardville, 7·08 inches; Drifton, 5·69 inches; Chambersburg, 5·55 inches, and Carlisle, 5·14 inches; while Erie had but 2·26 inches; Wysox, 2·31 inches; Bethlehem, 2·33 inches, and Meadville, 2·56 inches. The heavy rains occurred on the 9th, 18th and 28th. The latter, in many places, was attended by severe hail storms. Several stations report a light snowfall on the 15th.

WIND AND WEATHER.

No general and severe storms passed over the State during the month. Several sections were visited on the 28th by a tornado, which did a large amount of damage. The following are extracts from the reports of observers:

Rochester, 1.30 P. M.—Warning was given of the approach of a severe storm by loud thunder. The wind increased in velocity until fences, house

roofs, and trees were carried away. The Baptist Church was almost demolished and the Presbyterian Church badly damaged.

Huntingdon, 3 P. M.—Severe hail storm. Hail the size of hens' eggs fell plentifully, breaking windows and injuring fruit.

Emporium, 3.35 P. M.—One of the most terrific storms for years. Cameron Iron Works demolished. Trees from six to eight inches in diameter snapped off. Much damage to forest trees.

New Castle, 1.30 P. M.—Worst storm for twelve years. Came from southwest. Rain poured in torrents. High wind. Country roads obstructed by fallen trees. Houses and barns blown to pieces. Crops badly damaged.

Oil City, 2.30 P. M.—Most disastrous tornado. A large number of persons injured. At Clintonville Presbyterian Church demolished. At Clarion several buildings blown down.

Chambersburg, 4 P. M.—Storm of wind, rain and hail. Thousands of windows broken and buildings injured. For a short time hail stones from five to nine inches in circumference fell.

Lititz, 7.30 P. M.—Terrible hail storm from northwest. Hail stones ranged in size from a marble to four ounces. Thousands of windows broken. Damage to growing crops very great.

Several other stations report hail storms, and thunder storms on the 28th, with damage by lightning.

Average number.—Rainy days, 16; clear days, 4; fair days, 11; cloudy days, 16.

Prevailing direction of wind, west.

MISCELLANEOUS PHENOMENA.

Thunder Storms.—Pittsburgh, 4th, 8th, 9th, 12th, 25th, 28th, 31st; Rochester, 12th, 25th, 27th, 28th; Charlesville, 4th, 9th, 10th, 12th, 18th, 28th; Reading, 9th, 28th, 29th; Kutztown, 12th, 14th, 28th, 29th; Hollidaysburg, 4th, 18th, 22d, 28th; Quakertown, 12th, 14th, 28th, 29th; Johnstown, 4th; Emporium, 4th, 9th, 12th, 28th, 29th; State College, 4th, 5th, 9th, 28th; Phillipsburg, 22d, 28th; West Chester 29th; Coatesville, 5th, 12th, 28th, 29th; Rimersburg, 4th, 9th, 12th, 18th, 27th; Grampian Hills, 4th, 12th, 18th; Catawissa, 10th, 18th, 28th; Meadville, 4th; Carlisle, 5th, 9th, 12th, 28th, 29th, 30th; Swarthmore, 9th, 12th, 14th, 28th, 29th, 30th; Uniontown, 4th, 8th, 9th, 26th, 28th; Chambersburg, 28th; McConnellsburg, 12th; Huntingdon, 4th, 9th, 10th, 12th, 28th; Indiana, 18th; Scranton, 14th; Lancaster, 4th, 5th, 9th, 12th, 28th, 29th; New Castle, 12th, 28th, 31st; Lebanon, 9th, 12th, 28th, 31st; Greenville, 28th; Pottstown, 28th; Bethlehem, 12th, 14th, 28th, 29th; Shamokin, 18th; New Bloomfield, 12th, 28th, 30th; Coudersport, 19th; Girardville, 28th; Somerset, 4th, 9th, 12th, 18th, 28th; Eagles Mere, 12th, 28th, 30th; Bernice, 28th, 29th; Montrose, 28th, 29th; Wellsboro, 9th, 10th, 28th, 29th, 31st; Franklin, 4th, 9th, 27th, 28th, 30th; Columbus, 4th, 9th, 28th, 31st; Dyberry, 1st, 14th, 28th, 29th.

Hail.—Rochester, 25th; Hollidaysburg, 9th; Wysox, 15th; Coatesville, 5th, 17th, 29th; Rimersburg, 9th, 12th; Carlisle, 12th; Uniontown, 12th, 28th; Chambersburg, 28th; McConnellsburg, 17th; Huntingdon, 17th, 21st, 28th;

Monthly Summary of Reports by Voluntary Observers of the Pennsylvania State Weather S

County.	Station.	Elevation above Sea Level (feet).	Barometer.			Temperature.														
							Maximum.		Minimum.				Daily Range.					Relative Humidity.	Dew Point.
			Mean.	Highest.	Lowest.	Mean.	Highest.	Date.	Lowest.	Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.		
Allegheny,	Pittsburgh,	847	29·938	30·310	29·640	61·4	85·2	28	37·2	17	71·2	52·5	18·7	31·7	3	9·8	23	67·7	49·8
Beaver,	Rochester,	801	. . .	. . .	. . .	57·1	85·0	28	31·0	17	71·8	48·0	23·8	38·0	3, 4	6·0	1	80·0	51·0
Bedford,	Charlesville,	1,300	. . .	. . .	. . .	57·3	86·0	28	28·0	17	67·6	46·6	21·0	37·5	6	5·0	24	76·3	50·0
Berks,	Reading— Selwyn Hall School,	. . .	. . .	. . .	. . .	58·3	82·0	29	32·0	3	66·0	50·4	15·6	. . .	. . .	. . .	. . .	82·0	52·6
Berks,	Kutztown— Keystone State Normal School,	540	. . .	. . .	. . .	59·1	87·3	29	37·8	3	63·9	52·5	11·4	27·1	29	1·7	15	. . .	. . .
Blair,	Altoona,	1,181	30·190	30·460	29·900	60·6	87·0	29	35·0	17	71·2	50·0	21·2	37·0	2	10·0	24	59·8	46·4
Blair,	Hollidaysburg,	947	. . .	. . .	. . .	57·9	86·0	28	27·0	17	70·1	45·3	24·8	41·0	2	9·0	24	80·8	52·1
Bradford,	Wysox,	718	. . .	. . .	. . .	57·4	81·0	10, 27	27·5	3	67·2	46·9	20·3	36·5	6	9·2	26	74·3	49·3
Bucks,	Quakertown,	536	29·950	30·320	29·760	57·1	84·7	29	29·0	3	70·6	47·6	23·0	32·0	6	5·7	11	80·0	52·9
Butler,	Butler,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cambria,	Johnstown,	1,184	24·865	30·160	29·600	56·5	90·0	28	30·0	17	71·1	48·4	22·7	41·0	7	8·0	24	73·2	47·5
Cameron,	Emporium,	1,030	. . .	. . .	. . .	60·4	86·0	28	27·0	17	69·1	45·7	23·4	38·0	6	8·0	25	66·1	49·0
Centre,	State College— Agricultural Experiment Station,	1,191	29·982	30·325	29·607	57·6	82·0	28	30·5	3	65·2	46·6	18·6	32·5	6	7·0	11	73·9	49·8
Centre,	Phillipsburg,	1,350	. . .	. . .	. . .	53·6	91·0	30	24·0	17	71·1	43·1	26·0	42·0	17	7·0	1	. . .	. . .
Chester,	West Chester,	455	29·998	30·271	29·752	58·9	86·0	29	36·0	3	67·1	51·7	15·4	28·0	29	5·0	18, 24	. . .	. . .
Chester,	Coatesville,	380	. . .	. . .	. . .	58·5	89·0	29	29·0	3	69·1	49·7	19·4	35·5	3	6·0	11	. . .	. . .
Clarion,	Rimersburg,	1,500	. . .	. . .	. . .	58·4	85·0	28	36·0	14, 15	65·3	52·4	12·9	26·0	21	1·0	26	. . .	. . .
Clarion,	Clarion— State Normal School,	1,530	. . .	. . .	. . .	55·6	81·5	28	36·5	15	64·0	50·3	13·7	24·0	21	2·5	26	74·8	48·2
Clearfield,	Grampian Hills,	1,450	. . .	. . .	. . .	55·6	85·0	28	28·0	17	66·7	46·1	20·6	32·0	6, 13	4·0	25	. . .	. . .
Clinton,	Lock Haven,	560	. . .	. . .	. . .	59·0	85·0	28	28·0	4	68·0	47·6	20·4	41·0	4	7·0	24	. . .	. . .
Columbia,	Catawissa,	491	. . .	. . .	. . .	60·5	84·5	29	31·0	3	69·0	51·1	17·9	36·0	21	7·0	1	77·0	54·8
Crawford,	Meadville— Allegheny College,	1,050	29·969	30·229	29·664	62·2	80·0	23, 28	33·0	17	70·0	50·0	20·0	39·0	23	10·0	19	71·8	53·0
Cumberland,	Carlisle,	480	. . .	. . .	. . .	60·6	86·5	29	40·5	2	68·1	54·3	13·8	28·5	3	3·0	24	87·0	57·0
Delaware,	Swarthmore— Swarthmore College,	190	29·996	30·250	29·775	58·7	84·6	29	34·0	3	67·9	50·9	17·0	28·1	6	5·7	24	75·0	50·8
Elk,	Ridgway,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Erie,	Erie,	681	29·970	30·380	29·590	54·5	81·0	4	36·0	2	62·9	47·7	15·2	30·0	4	6·0	18, 19	67·4	43·2
Fayette,	Uniontown,	1,000	29·942	30·225	29·715	63·8	82·0	27	32·0	17	70·8	50·9	19·9	40·0	3	7·0	23	70·5	54·8
Forest,	Tionesta,	1,038	. . .	. . .	. . .	54·0	83·0	28	20·0	16	71·5	47·3	24·2	35·0	13	5·0	17	73·0	45·2
Franklin,	Chambersburg— Wilson Female College,*	618	29·984	30·226	29·744	58·4	86·0	29, 30	30·0	3, 17	70·8	48·1	21·7	42·5	6	7·0	24	82·3	52·6
Fulton,	McConnellsburg,	875	. . .	. . .	. . .	59·3	86 o	29	30·0	17	71 o	48·9	22·1	39·0	6	6·0	11	76·5	51·2
Huntingdon,	Huntingdon— The Normal College,	650	. . .	. . .	. . .	58·2	85·0	28	22·0	6	70·0	45·5	24·5	54·0	6	7·8	24	76·1	50·2
Indiana,	Indiana— State Normal School,	1,350	. . .	. . .	. . .	57·9	85·0	28	27·0	17	68·8	46·4	22·4	36·0	17	9·8	24	75·8	50·0
Lackawanna,	Scranton,	750	. . .	. . .	. . .	57·4	83·0	29	30·0	3	68·8	49·7	19·1	38·0	21	8·0	26	76·7	50·1
Lancaster,	Lancaster— Franklin and Marshall College,	413	29·992	30·284	29·727	59·6	86·1	29	31·5	3	68·4	50·0	18·4	30·0	3	5·9	11	79·9	53·3
Lawrence,	New Castle,	931	. . .	. . .	. . .	60·5	85·0	28	27·0	17	71·0	46·6	24·4	40·0	6	13·0	8	72·0	50·7
Lebanon,	Lebanon,	480	30·032	30·384	29·739	58·3	85·7	29	30·2	3	67·8	49·1	18·7	35·6	7	5·0	18	79·9	52·0
Luzerne,	Drifton— Drifton Hospital,	1,655	. . .	. . .	. . .	55·0	84·0	29	24·0	16	67·4	46·3	21·1	39·0	21	9·0	8	. . .	. . .
Lycoming,	Williamsport,	525	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
McKean,	Smethport,	. . .	. . .	. . .	. . .	54·5	79·0	9	27·0	17	62·4	44·1	18·3	39·0	4	6·0	25	78·0	46·8
Mercer,	Greenville— Thiel College,	1,000	29·883	30·167	29·609	55·7	80·8	28	30·0	20	68 6	47·9	20·7	41·9	21	12·1	18	73·1	37·6
Monroe,	Stroudsburg,	430	. . .	. . .	. . .	56·5	84·0	29	28·0	3	68·4	47·6	20·8	41·0	21	8·0	30	78·8	49·4
Montgomery,	Pottstown,	150	. . .	. . .	. . .	60·5	87·0	29	35·0	3	68·0	53·3	14·7	30·0	21	1·0	18	77·0	52·4
Northampton,	Bethlehem,	360	29·968	30·235	29·700	59·5	86·0	29	32·0	3	69·6	48·5	21·1	38·0	19	8·0	26	72·0	50·3
Northumberland,	Shamokin,	733	. . .	. . .	. . .	58·1	85·0	29	26·0	3	67·7	47·6	20·1	38·0	21	8·0	25	72·8	49·0
Perry,	New Bloomfield,	400	. . .	. . .	. . .	57·7	85·0	29	29·0	17	67·6	47·2	20·4	38·0	3, 6	4·0	18	. . .	. . .
Philadelphia,	Philadelphia,	117	30·010	30·300	29·710	60·6	86·6	29	40·5	2, 17	69·0	53·5	15·5	28·8	29	6·0	31	70·4	50·0
Pike,	Blooming Grove,	800	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Potter,	Coudersport,	. . .	. . .	. . .	. . .	54·9	86·0	28	23·5	17	63·1	40·1	23·0	41·0	6	11·0	19	72·4	46·2
Schuylkill,	Girardville,	1,000	30·026	30·293	29·699	57·6	82 o	29	31·0	3	68·8	48·0	20·8	36·0	22	5·0	18	. . .	. . .
Somerset,	Somerset,	2,250	. . .	. . .	. . .	53·0	83·0	28	28·0	3	67·6	44·8	22·8	47·5	3	6·0	25	83·8	47·0
Sullivan,	Eagles Mere,	2,000	. . .	. . .	. . .	52·5	76·0	29	29·0	17	59·1	43·8	15·3	26·0	6	6·0	18	72·9	43·2
Sullivan,	Bernice,	2,000	30·179	30·472	29·907	52·6	77·0	10, 29	24·0	3	63·0	42·6	20·4	48·0	6	6·0	26	75·8	45·2
Susquehanna,	Montrose,	1,636	. . .	. . .	. . .	56·6	81·0	27	31·0	17	64·1	47·6	16·5	27·0	27	9·0	18	. . .	. . .
Tioga,	Wellsboro,	1,327	29·977	30·363	29·790	54·9	80·0	27	30·0	21	62·2	46·9	15·3	69·2	29	39·2	16	70·3	48·0
Venango,	Franklin,	. . .	. . .	. . .	. . .	56·8	81·0	28	36·0	17	65·4	50·5	14·9	28·0	21	3·0	8	72·0	48·5
Washington,	Scenery Hill,	1,730	. . .	. . .	. . .	58·7	81·0	28	34·0	2	65·7	49·5	16·2	35·5	3	7·0	9	. . .	. . .
Washington,	Washington,	1,175	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Warren,	Columbus,	1,410	30·064	30·366	29·765	55·3	82·0	28	26·0	17, 21	67·4	43·2	24·2	54·0	21	0·0	1	. . .	. . .
Wayne,	Dyberry,	1,100	. . .	. . .	. . .	53·5	78·0	29, 30	24·0	3	63·8	38·9	30·9	39·0	6	7·0	28	. . .	. . .
Wayne,	Honesdale,	1,000	. . .	. . .	. . .	53·7	76·0	29	27·0	3	63·8	43·7	20·1	37·0	6	6·0	8	. . .	. . .
Westmoreland,	Greensburg,	1,075	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
York,	York,	385	. . .	. . .	. . .	60·2	87·5	29	32·0	3	68·9	51·3	17·6	35·6	6	5·0	18	75·3	52·0

* Observations taken at 8 A. M. and 8 P. M.

Voluntary Observers of the Pennsylvania State Weather Service for May, 1

Temperature.									Relative Humidity.	Dew Point.	Precipitation.		Number
Minimum.		Mean of Maximum.	Mean of Minimum.	Daily Range.									
Lowest.	Date.			Mean.	Greatest.	Date.	Least.	Date.			Total Inches.	Number of Days Rainfall.	Clear.
37·2	17	71·2	52·5	18·7	31·7	3	9·8	23	67·7	49·8	4·13	18	2
31·0	17	71·8	48·0	23·8	38·0	3, 4	6·0	1	80·0	51·0	3·32	12	7
28·0	17	67·6	46·6	21·0	37·5	6	5·0	24	76·3	50·0	4·83	20	7
32·0	3	66·0	50·4	15·6	. . .	. . .	. . .	. . .	82·0	52·6	3·83	15	5
37·8	3	63·9	52·5	11·4	27·1	29	1·7	15	. . .	. . .	3·11	15	5
35·0	17	71·2	50·0	21·2	37·0	2	10·0	24	59·8	46·4	4·08	15	. . .
27·0	17	70·1	45·3	24·8	41·0	7	9·0	24	80·8	52·1	6·94	15	11
27·5	3	67·2	46·9	20·3	36·5	6	9·2	26	74·3	49·3	2·31	15	5
29·0	3	70·6	47·6	23·0	32·0	6	5·7	11	80·0	52·7	3·09	20	4
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
30·0	17	71·1	48·4	22·7	41·0	7	8·0	24	73·2	47·5	4·74	18	10
27·0	17	69·1	45·7	23·4	38·0	6	8·0	25	66·1	49·0	4·63	18	7
30·5	3	65·2	46·6	18·6	32·5	6	7·0	11	73·9	49·8	6·26	17	8
24·0	17	71·1	45·1	26·0	42·0	17	7·0	1	. . .	. . .	4·96	19	6
36·0	3	67·1	51·7	15·4	28·0	29	5·0	18, 24	. . .	. . .	4·11	21	11
29·0	3	69·1	49·7	19·4	35·5	3	6·0	11	. . .	. . .	2·89	20	6
36·0	14, 15	65·3	52·4	12·9	26·0	21	1·0	26	. . .	. . .	. . .	12	7
36·5	15	64·0	50·3	13·7	24·0	21	2·5	26	74·8	48·2	3·46	11	3
28·0	17	66·7	46·1	20·6	32·0	6, 13	4·0	25	. . .	. . .	4·58	13	7
28·0	4	68·0	47·6	20·4	41·0	4	7·0	24	. . .	. . .	3·87	17	10
31·0	3	69·0	51·1	17·9	36·0	21	7·0	1	77·0	54·8	5·20	15	4
33·0	17	70·0	50·0	20·0	39·0	23	10·0	19	71·8	53·0	2·56	8	. . .
40·5	2	68·1	54·3	13·8	28·5	3	3·0	24	87·0	57·0	5·14	19	6
34·0	3	67·9	50·9	17·0	28·1	6	5·7	24	75·0	50·8	3·02	14	5
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
36·0	2	69·9	47·7	15·2	30·0	4	6·0	18, 19	67·4	43·2	2·26	14	3
32·0	17	70·8	50·9	19·9	40·0	3	7·0	23	70·5	54·8	4·72	14	12
29·0	16	71·5	47·3	24·2	35·0	13	5·0	17	73·6	45·2	. . .	. . .	0
30·0	3, 17	70·8	48·1	21·7	42·5	6	7·0	24	82·3	52·6	5·55	15	12
30·0	17	71·0	48·9	22·1	39·0	6	6·0	11	76·5	51·2	4·70	17	5
22·0	6	70·0	43·3	24·5	54·0	6	7·8	24	76·1	50·2	8·41	14	4
27·0	17	68·8	46·4	22·4	36·0	17	9·8	24	75·8	50·0	5·30	17	7
30·0	3	68·8	49·7	19·1	38·0	21	8·0	26	76·7	50·1	3·13	19	3
31·5	3	68·4	50·0	18·4	30·0	3	5·9	11	79·9	53·3	3·39	20	5
27·0	17	72·0	46·6	24·4	40·0	6	13·0	8	72·0	50·7	2·73	11	3
30·2	3	67·8	49·1	18·7	35·6	7	5·0	18	79·9	52·0	5·08	22	7
24·0	16	67·4	46·3	21·1	39·0	21	9·0	8	. . .	. . .	5·69	13	8
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
27·0	17	62·4	44·1	18·3	39·0	4	6·0	25	78·0	46·8	. . .	. . .	3
30·0	20	68·6	47·9	20·7	41·9	21	12·1	18	73·1	37·6	2·63	14	1
28·0	3	68·4	47·6	20·8	41·0	21	8·0	30	78·8	49·4	5·13	15	10
35·0	3	68·0	53·3	14·7	30·0	21	1·0	18	77·0	52·4	4·25	14	12
32·0	3	69·6	48·5	21·1	38·0	19	8·0	26	72·0	50·3	2·33	15	9
26·0	3	67·7	47·6	20·1	38·0	21	8·0	25	71·8	49·0	6·11	19	5
29·0	17	67·6	47·2	20·4	38·0	3, 6	4·0	18	. . .	. . .	6·55	16	4
42·5	2, 17	69·0	53·5	15·5	28·8	29	6·0	31	70·4	50·0	3·46	19	2
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
23·5	17	63·1	40·1	23·0	41·0	6	11·0	19	72·4	46·2	3·80	11	10
31·0	3	68·8	48·0	20·8	36·0	22	5·0	18	. . .	. . .	7·08	17	11
28·0	3	67·6	44·8	22·8	47·5	3	6·0	25	83·8	47·0	5·85	18	8
29·0	27	59·1	43·8	15·3	26·0	6	6·0	18	72·9	43·2	3·70	15	2
24·0	3	63·0	42·6	20·4	48·0	6	6·0	26	75·8	45·2	9·55	17	5
31·0	17	64·1	47·6	16·5	27·0	27	9·0	18	. . .	. . .	3·03	15	6
30·0	21	62·2	46·9	15·3	69·2	29	39·2	16	70·3	48·0	3·16	14	8
36·0	17	65·4	50·5	14·9	28·0	21	3·0	8	72·0	48·5	4·09	14	4
34·0	2	65·7	49·5	16·2	35·5	3	7·0	9	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
26·0	17, 21	67·4	43·2	24·2	54·0	21	0·0	1	. . .	. . .	2·80	18	8
24·0	3	63·8	38·9	30·9	39·0	6	7·0	28	. . .	. . .	3·86	14	3
27·0	3	63·8	43·7	20·1	37·0	6	6·0	8	. . .	. . .	2·98	12	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
32·0	3	68·9	51·3	17·6	35·6	6	3·0	18	75·3	52·0	5·10	22	6

ON.	NUMBER OF DAYS.			WIND.	OBSERVERS.
	Clear.	Fair.	Cloudy.	Prevailing Direction.	
	2	19	10	. . .	Oscar D. Stewart, Sgt. Sig. Corps.
	7	16	8	W	Hartford P. Brown, Jr.
	7	8	16	N, W	Rev. A. Thos. G. Apple.
	5	8	18	W	Prof. George A. Ruddle.
	5	7	19	. . .	Prof. J. H. Rohrbach.
	. . .	. . .	. . .	. . .	Dr. Charles B. Dudley.
	11	6	14	W	Prof. J. A. Stewart.
	5	7	19	NW	Charles Beecher.
	4	9	18	NW	J. L. Heacock.
	. . .	. . .	. . .	. . .	J. E. Forsythe.
	10	15	6	. . .	E. C. Lorentz.
	7	10	14	NW	T. B. Lloyd.
	8	8	15	E	Prof. Wm. Frear.
	6	17	8	S, W	L. Ray Morgan.
	11	6	14	N, W, E	Jesse C. Green, D.D.S.
	6	9	16	E	W. T. Gordon.
	7	13	11	W	Rev. W. W. Deatrick, A.M.
	3	17	11	E	C. M. Thomas, B.S.
	7	11	13	E	Nathan Moore.
	10	9	12	W	Prof. John A. Robb.
	4	11	16	S	Robert M. Graham.
	. . .	. . .	. . .	. . .	Prof. J. H. Montgomery.
	6	7	18	W	J. E. Pague.
	5	11	15	SE	Prof. Susan J. Cunningham.
	. . .	. . .	. . .	. . .	Joe Messinger.
	3	20	8	S	Peter Wood, Sgt. Sig. Corps.
	12	15	4	SW	Wm. Hunt.
	0	9	22	S	Robert L. Haslet.
	12	7	12	. . .	Miss Mary A. Ricker.
	5	16	10	W	Thomas F. Sloan.
	4	5	22	W	Prof. W. J. Swigart.
	7	10	14	SW	Prof. Albert E. Maltby.
	5	13	13	SE, NW	T. F. Heebner, M.D.
	5	9	17	E	A. M. Schmidt, A.B.
	3	14	14	SE	Wm. T. Butz.
	7	9	15	SW, NE	George W. Hayes, C.E., Ph.G.
	8	7	16	. . .	H. D. Miller, M.D.
	. . .	. . .	. . .	. . .	E. H. Baker.
	3	12	16	SW	Armstrong & Brownell.
	1	15	15	SW	Prof. S. H. Miller.
	10	2	19	SE	N. C. Miller, M.D.
	12	3	16	W	Charles Moore, D.D.S.
	9	7	15	W	Lerch & Rice.
	5	11	15	W	G. R. Hanley.
	4	6	21	E	Frank Mortimer.
	2	11	18	NW	Luther M. Dey, Sgt. Sig. Corps.
	. . .	. . .	. . .	. . .	John Grathwohl.
	10	3	18	W	D. W. Butterworth.
	11	9	11	NW	E. C Wagner.
	8	9	14	SE, SW	W. M. Schrock.
	2	12	17	S	E. S. Chase.
	5	14	12	N, SW	C. R. Claghorn.
	6	11	14	N	A. H. Berlin.
	8	11	12	N	H. D. Deming.
	4	16	11	W	Prof. N. P. Kinsley.
	. . .	. . .	. . .	. . .	Jacob Gayman.
	. . .	. . .	. . .	. . .	Harrison Otis.
	8	11	12	SW	Wm. Loveland.
	3	11	17	W	Theodore Day.
	. . .	. . .	. . .	. . .	John Torrey.
	. . .	. . .	. . .	. . .	H. S. Brunot.
	6	13	12	NW	Mrs. L. H. Grenewald.

T. F. TOWNSEND, *Sergeant Signal Corps, Assistant.*

	Erie.																														
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PRECIPITATION FOR MAY, 1888.

	Erie.	Meadville.	Greenville.	New Castle.	Rochester.	Pittsburgh.	Columbus.	Clarion.	Uniontown.	Indiana.	Somerset.	Johnstown.	Grampian Hills.	Emporium.	Phillipsburg.	Hollidaysburg.	Altoona.	Charlesville.	State College.	Huntingdon.	McConnellsburg.	Chambersburg.	Lock Haven.	New Bloomfield.	Carlisle.	York.	Wysox.	Eagles Mere.	Bernice.	Catawissa.	Shamokin.	Girardville.	Lebanon.	Lancaster.	Montrose.	Drifton.	Scranton.	Reading.	Kutztown.	Pottstown.	West Chester.	Coatesville.	Doberry.
1	.11	. .	.01	. .	. .	. .	.04	.03	.18	.31	.05	.05	.05	.01	.03	. .	.01	.04	.06	. .	. .	.18	.10	.05	.10	.12	. .	.16	.16	.19	.13	. .	.35	.10	.20	.54	.22	.22	.25	.15	.24	.10	
2	.01	. .	. .	. .	. .	. .	. .	.04	. .	.03	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	
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4	.16	.23	.11	.10	.44	.29	.01	. .	.51	.50	.88	.31	. .	.06	. .	.36	. .	.43	.25	.41	.22	.30	.08	.60	. .	.49	.07	.17	. .	.28	.12	.34	.24	. .	. .	. .	. .	. .	. .	.20	.02	.01	
5	. .	. .	. .	. .	. .	. .	.38	.33	. .	.20	.23	.11	.53	.08	.50	.23	.45	.62	.23	.	.23	. .	.12	. .	.28	.49	. .	. .	.14	. .	.10	.	.05	.23	.14	. .	.08	.48	.25	. .	. .	.07	
6	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	
7	. .	. .	. .	. .	.07	. .	. .	. .	. .	. .	. .	. .	. .	. .	.03	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	
8	.22	.11	.09	.07	.05	.34	.22	.04	.33	.40	.20	.35	. .	.05	.11	.67	. .	.35	.13	.50	.33	.12	.24	. .	. .	.01	.25	.23	.16	.02	. .	.22	.02	.01	.14	. .	.09	. .	. .	. .	. .	. .	
9	.28	.63	.25	.27	.04	.07	.28	.79	.29	.20	.22	1.11	.64	1.16	.36	1.26	.27	.66	.23	.20	.21	.63	.10	.40	.20	.30	.06	. .	. .	.35	.23	.33	1.23	.24	.15	. .	.13	. .	.20	.07	.02	.02	
10	. .	. .	.03	. .	. .	. .	.07	. .	. .	. .	.23	.29	. .	. .	.45	.76	.37	.05	1.21	1.00	.08	.04	.18	.90	.19	.30	.06	.07	. .	.87	.36	.72	.05	.10	. .	.30	.04	. .	. .	.10	.04	.03	
11	.02	. .	.04	.10	. .	.02	. .	. .	. .	. .	.06	. .	. .	. .	. .	. .	.37	.01	. .	. .	. .	.22	.17	.10	.33	.01	.02	.17	.09	.02	.63	.12	.06	.15	.17	.68	.11	.30	.35	.50	.44	.37	
12	. .	.28	.03	.21	.19	.34	.04	.65	.28	.38	.50	.16	.88	.81	.18	.83	.08	.20	.44	.98	.92	.50	.95	.60	.02	.88	.37	.22	.25	.16	.14	.27	.36	.34	.23	.17	.08	.27	.23	.49	.34	.33	
13	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.01	.32	. .	.57	. .	. .	. .	. .	. .	. .	. .	.80	.01	. .	. .	. .	. .	. .	. .	.02	. .	. .	.06	. .	. .	. .	.16	.02	
14	. .	. .	.01	. .	. .	.01	. .	. .	.21	.10	.15	.07	.10	.03	.05	. .	.02	.06	.08	. .	. .	. .	.06	. .	.01	.13	.03	. .	.07	. .	. .	.19	.01	.08	.01	.10	.30	. .	. .	.35	.07	.14	
15	.10	. .	. .	. .	.14	. .	.05	. .	. .	. .	. .	. .	. .	. .	.05	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.01	. .	.05	.06	.17	.35	.10	.15	.01	. .	.20	. .	. .	. .	.02	. .	. .	
16	.02	.10	.03	.04	. .	.02	.15	. .	. .	.04	.20	. .	.08	.08	.36	. .	.03	.06	.07	.09	.13	.11	.07	.10	.10	.06	.10	.26	.14	.13	.20	.22	.10	.09	.18	.21	.12	.08	.12	. .	.12	.10	
17	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	
18	.18	.15	.13	.27	.72	.89	.39	.27	1.08	1.20	1.07	1.05	.70	.35	.21	1.38	.34	.59	.21	.36	.47	.39	.04	.40	.20	.20	.02	.31	.15	1.20	.31	1.27	.22	.40	.21	.26	.16	.16	.31	.50	.06	.08	
19	. .	. .	. .	. .	. .	.15	.02	.13	.42	.08	.47	.20	. .	.23	.43	.32	.75	.14	.80	1.38	.04	. .	.01	.30	.22	.15	. .	. .	.10	. .	.54	. .	.12	. .	. .	.91	.11	.20	. .	. .	.03	.01	
20	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	
21	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	
22	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	
23	. .	. .	.03	.06	.11	.05	. .	. .	. .	.25	. .	.17	.11	.16	. .	.08	. .	.54	. .	. .	.21	.16	. .	. .	.01	.13	. .	. .	. .	.05	.05	.06	.03	.13	. .	. .	. .	.12	.07	. .	.21	.14	
24	. .	.35	.01	. .	. .	.01	.02	. .	.41	.13	.56	.19	.12	.08	.83	.18	.05	.25	.96	.88	.09	.78	.40	1.00	1.10	.53	. .	.03	.06	.12	.12	.08	.45	.30	. .	.25	.02	.18	. .	.40	.40	.40	
25	.04	. .	.43	. .	.58	.71	.01	. .	.11	.25	.15	.40	.10	.01	.26	.15	.07	.15	.07	.11	.05	.08	. .	.10	.14	.04	.08	.46	.03	.01	.06	.09	.24	.17	.02	.26	.01	.05	.17	.30	.26	.08	
26	.04	. .	.08	.27	.06	.14	.05	.09	.05	.38	.18	.07	.24	.10	.14	.13	.27	.16	.20	.43	.89	.13	.12	.10	.06	.15	.02	. .	.05	. .	.07	.12	.11	. .	.08	.17	.19	.07	.21	.10	.03	.06	
27	. .	. .	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	.07	. .	. .	. .	. .	. .	. .	. .	. .	. .	.01	. .	.11	.10	.01	. .	.02	.14	.05	.13	. .	. .	. .	. .	. .	. .	. .	. .	
28	1.00	.71	1.28	1.18	.90	.65	.68	1.03	.34	.80	.35	.10	.70	.93	. .	.21	. .	.06	1.21	1.89	.07	.24	1.06	1.20	.03	.01	.69	1.26	.60	1.55	2.72	.71	.05	.22	.12	.34	1.20	.51	1.00	.01	. .	
29	.08	. .	. .	. .	. .	.01	.03	. .	.21	.05	.25	.01	. .	.25	.57	.01	.43	.03	. .	.04	.02	. .	.02	.30	.76	.35	. .	. .	.39	. .	1.05	. .	.22	.55	.88	1.72	.75	.11	.26	. .	.19	.46	
30	. .	. .	.07	. .	. .	.04	.03	. .	. .	. .	. .	. .	. .	. .	. .	.06	.06	.03	. .	. .	.89	. .	. .	.10	. .	.03	.06	.03	. .	. .	. .	. .	.03	.24	.03	. .	. .	.13	.04	.03	1.19	.29	
31	. .	. .	. .	.16	. .	.39	.28	.06	.30	. .	.10	.10	.33	.23	.01	.37	. .	.37	.04	.14	.45	1.67	.15	.30	.58	.69	.37	.18	.07	.07	.08	.09	.28	.05	.37	. .	.12	.20	.12	.15	.25	.16	
	2.26	2.56	2.63	2.73	3.32	4.13	2.80	3.46	4.79	5.30	5.85	4.74	4.58	4.63	4.96	6.94	4.08	4.83	6.26	8.41	4.70	5.53	3.87	6.55	5.14	5.10	2.31	3.72	2.55	5.20	6.11	7.08	5.08	3.39	3.03	5.67	3.13	3.83	3.11	4.25	4.11	2.89	

PRECIPITATION FOR MAY, 1888.

	Carlisle.	York.	Wyoox.	Eagles Mere.	Bernice.	Catawissa.	Shamokin.	Girardville.	Lebanon.	Lancaster.	Montrose.	Drifton.	Scranton.	Reading.	Kutztown.	Pottstown.	West Chester.	Coatesville.	Dyberry.	Honesdale.	Bethlehem.	Quakertown.	Swarthmore.	Philadelphia.	Stroudsburg	Coudersport.	Schuylkill.
05	'10	'12	. .	'16	'16	'19	'13	. .	'35	'10	'20	'54	'22	'22	'25	'15	'24	'10	'12	'24	'22	'17	'07	'03	'28	'10	'1
.	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.
.	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	'08	. .	. .	. .	. .	. .	. .	.
60	. .	'49	'07	'17	. .	'28	'12	'34	'24	. .	. .	. .	. .	. .	. .	'20	'02	'01	. .	. .	'24	'11	. .	'02	'44	. .	3
.	'28	'49	. .	. .	'14	. .	'10	.	'05	'23	'14	. .	'08	'48	'25	. .	. .	'07	'25	. .	. .	. .	. .	. .	. .	'10	.
.	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.
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.	. .	'01	'25	'23	'16	'02	. .	'22	'02	'01	'14	. .	'09	. .	. .	. .	. .	. .	. .	'20	'13	. .	. .	. .	. .	. .	.
40	'20	'30	'06	. .	. .	'35	'23	'33	1'23	'24	'15	. .	'13	. .	'20	'07	'02	'08	'19	. .	'10	'10	'11	'04	'25	'70	'1
30	'19	'30	'06	'07	. .	'87	'26	'72	'05	'10	. .	'30	'04	. .	. .	'10	'04	'03	'35	. .	'08	'05	'02	'35	'20	. .	.
10	'33	'01	'02	'17	'09	'02	'03	'12	'06	'15	'17	'68	'11	'30	'35	'50	'44	'37	. .	'19	'39	'57	'88	'71	'98	. .	.
60	'02	'88	'37	'22	'25	'16	'14	'27	'36	'34	'23	'17	'08	'27	'23	'40	'34	'33	'28	. .	'18	'23	. .	'28	'30	'90	'7
.	'80	'01	. .	. .	. .	. .	. .	. .	. .	'02	. .	. .	'06	. .	. .	. .	'16	'02	. .	. .	. .	'06	'15	'07	. .	. .	.
.	'01	'13	'03	. .	'07	. .	. .	'19	'01	'08	'01	'10	'30	. .	. .	'35	'07	'14	'20	'30	'01	'23	'17	'07	'33	. .	'2
.	. .	'01	. .	'05	'06	'17	'35	'10	'15	'01	. .	. .	'20	. .	. .	. .	'02	. .	. .	. .	. .	'01	. .	'02	. .	. .	.
10	'10	'06	'10	'26	'14	'13	'20	'22	'10	'09	'18	'21	'12	'08	'12	. .	'12	'10	'52	'24	. .	'08	'04	'04	'01	'10	'0
.	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.
40	'20	'20	'02	'31	'15	1'20	'31	1'27	'22	'40	'21	'26	'16	'16	'31	'50	'06	'08	. .	'50	. .	'10	. .	. .	. .	'20	'3
30	'22	'15	. .	. .	'10	. .	'54	.	'12	. .	. .	'91	'11	'20	. .	. .	'03	'01	'53	'03	. .	'27	'02	'03	'70	'30	. .
.	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.
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.	'01	'13	. .	. .	. .	'06	'05	'06	'03	'13	. .	. .	. .	'12	'07	. .	'21	'14	. .	. .	. .	'07	'26	'25	. .	. .	.
00	1'10	'53	. .	'03	'06	'12	'12	'08	'45	'30	. .	'25	'02	'18	. .	'40	'40	'40	. .	'10	'10	'16	'19	'13	'18	'10	.
10	'14	'04	'08	'46	'03	'01	'06	'09	'24	'17	'02	'26	'01	'05	'17	'30	'26	'08	'25	. .	'0	'03	'43	'35	'03	'20	.
10	'06	'15	'02	. .	'05	. .	'07	'12	'11	. .	'08	'17	'19	'07	'21	'10	'03	'06	'10	'18	'11	'16	'05	'01	'06	. .	'6
.	'01	. .	'11	'10	'01	. .	'02	'14	'05	'13	. .	. .	. .	. .	. .	. .	'01	'02	. .	. .	'01	. .	. .	. .	. .	. .	.
20	'03	'01	'69	1'26	'60	1'55	1'55	2'72	'71	'05	'22	'12	'34	1'20	'51	1'00	'01	. .	'15	'73	'63	'44	. .	'02	'23	'70	.
30	'76	'35	. .	. .	'39	. .	1'05	. .	'22	'55	'88	1'72	'75	'11	'26	. .	'19	'46	'50	. .	. .	'08	.	'12	1'09	'40	'7
10	. .	'03	'06	'03	. .	. .	. .	. .	'03	'24	'03	. .	. .	'13	'04	'03	1'19	'89	'15	. .	'09	'03	'30	'48	. .	. .	'0
10	'58	'69	'37	'18	'07	'07	'08	'09	'28	'03	'37	. .	'12	'20	'12	'15	'25	'16	'27	'17	'01	'07	'31	'24	'01	. .	'0
55	5'14	5'10	2'31	3'70	2'55	5'20	6'11	7'08	5'08	3'39	3'03	5'69	3'13	3'83	3'11	4'25	4'11	2'89	3'86	2'98	2'33	3'08	3'02	3'46	5'13	3'80	3'6

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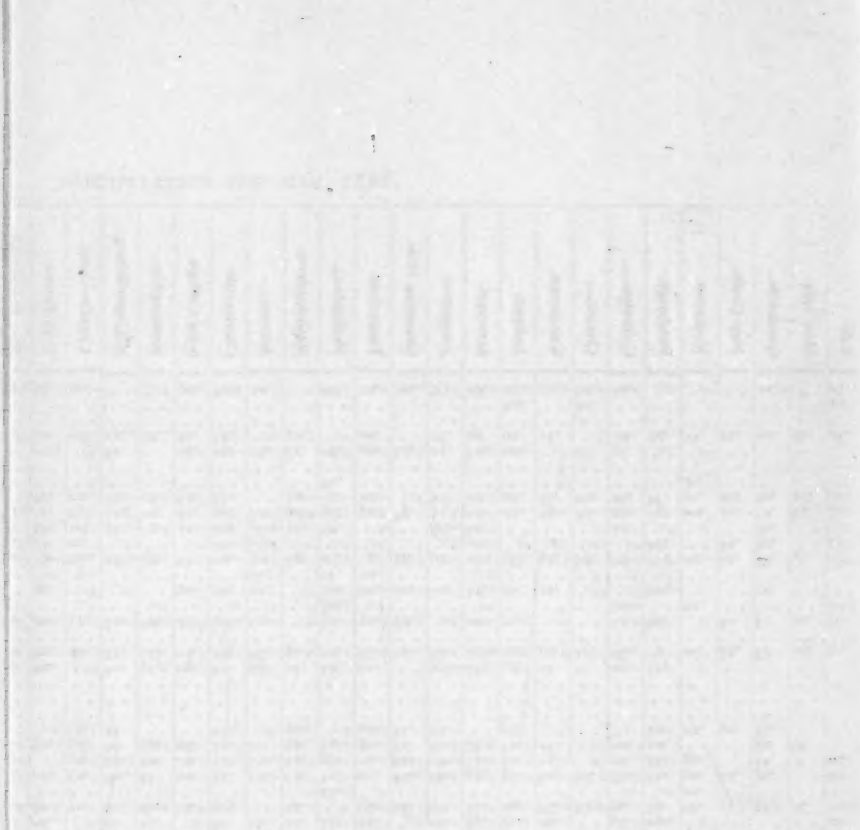

Indiana, 28th; Scranton, 28th; Smethport, 3d; Greenville, 28th; Montrose, 16th; Wellsboro, 15th; Dyberry, 15th.

Tornadoes.—Rochester, 28th; Emporium, 28th; Phillipsburg, 28th; Rimersburg, 28th; Smethport, 28th; Shamokin, 28th; Coudersport, 28th; Franklin, 28th.

Frosts.—Pittsburgh, 17th, 20th; Rochester, 17th, 20th; Charlesville, 3d, 17th, 21st; Kutztown, 17th; Wysox, 3d, 6th, 16th, 17th, 20th, 21st; Quakertown, 3d, 17th; Johnstown, 17th; Emporium, 17th, 20th, 21st; State College, 17th; West Chester, 17th, 21st; Coatesville, 3d, 21st; Rimersburg, 17th, 20th; Grampian Hills, 17th, 20th, 21st; Lock Haven, 17th, 20th, 21st; Catawissa, 3d, 17th, 21st; Carlisle, 17th; Erie, 20th; Uniontown, 17th; Tionesta, 13th, 17th, 21st; Chambersburg, 4th, 5th, 6th; Huntingdon, 2d, 3d; Indiana, 17th; New Castle, 17th, 18th; Lebanon, 3d; Greenville, 17th, 20th, 21st; Pottstown, 3d; Bethlehem, 17th; Shamokin, 21st; New Bloomfield, 17th, 21st; Philadelphia, 2d, 17th; Coudersport, 17th, 21st; Girardville, 22d; Somerset, 17th; Eagles Mere, 17th; Bernice, 3d; Montrose, 17th; Wellsboro, 2d, 3d, 5th, 6th, 7th, 14th, 15th, 16th, 17th; Franklin, 17th; Columbus, 3d, 6th, 13th, 17th, 20th, 21st; Dyberry, 15th.

Auroras.—State College, 20th; Coatesville, 20th; Catawissa, 20th; Scranton, 20th; Greenville, 7th, 20th; Stroudsburg, 20th; Girardville, 2d; Somerset, 20th; Eagles Mere, 20th; Wellsboro, 20th; Franklin, 20th.

Solar Halos.—Charlesville, 9th, 10th, 20th, 21st, 22d, 28th; Somerset, 20th; Eagles Mere, 22d, 23d; Wellsboro, 23d; Franklin, 10th, 12th; Dyberry, 23d.

Lunar Halos.—Pittsburgh, 22d, 23d; Rochester, 22d; Charlesville, 19th, 21st, 22d; Kutztown, 19th; Altoona, 19th; Wysox, 22d; Quakertown, 19th, 21st, 22d; State College, 21st, 22d; West Chester, 17th, 19th, 21st, 22d; Grampian Hills, 22d; Catawissa, 17th, 20th; Carlisle, 19th, 20th, 21st, 22d; Swarthmore, 20th, 21st, 22d; Chambersburg, 17th; Indiana, 19th, 21st, 22d; Scranton, 22d; Lancaster, 16th, 17th, 19th, 21st; New Castle, 25th; Lebanon, 19th, 22d; Smethport, 22d; Stroudsburg, 19th, 22d; Pottstown, 21st; Shamokin, 17th, 19th; New Bloomfield, 19th, 21st; Philadelphia, 21st, 22d; Girardville, 17th; Somerset, 19th, 21st, 22d; Eagles Mere, 17th, 22d; Wellsboro, 23d; Franklin, 22d; Dyberry, 22d; Honesdale, 19th, 21st.

Lunar Coronæ.—Charlesville, 20th; Huntingdon, 20th, 21st, 22d; Lebanon, 15th, 17th, 19th, 22d; Smethport, 19th; Stroudsburg, 17th, 21st; Eagles Mere, 22d; Dyberry, 14th. T. F. T.

WEATHER SIGNALS.

Displayman.	*Station.*
U. S. Signal Office,	Philadelphia.
Wanamaker & Brown,	"
Pennsylvania Railroad Company,	"
Continental Brewing Company,	"
Samuel Simpson,	"
B. T. Babbitt,	"

Displayman.	*Station.*
Western Meat Company,	Philadelphia.
Neptune Laundry,	"
Chester Oil Company,	Chester.
C. W. Burkhart,	Shoemakerville.
A. N. Lindenmuth,	Allentown.
C. B. Whitehead,	Bradford.
Capt. Geo. R. Guss,	West Chester.
Werner & Son,	Emporium.
C. E. Lenhart,	Latrobe.
Thomas F. Sloan,	McConnellsburg.
J. H. Fulmer,	Muncy.
W. T. Butz,	New Castle.
S. W. Morrison,	Oxford.
Capt. A. Goldsmith,	Quakertown.
J. L. Morrison,	Sharon.
Wm. A. Engel,	Shenandoah.
Wm. Schrock,	Somerset.
Postmaster,	Meadville.
Frank Ross,	Oil City.
Lerch & Rice,	Bethlehem.
John W. Aitken,	Carbondale.
Signal Office,	Erie.
J. R. Raynsford,	Montrose.
E. P. Wilbur & Co.,	South Bethlehem.
Agricultural Experiment Station,	State College.
Signal Office,	Pittsburgh.
E. H. Baker,	Williamsport.
New Era,	Lancaster.
State Normal School,	Clarion.
Clarion Collegiate Institute,	Rimersburg.
E. S. Chase,	Eagles Mere.
Thiel College,	Greenville.
D. G. Hurley,	Altoona.
Armstrong & Brownell,	Smethport.
J. E. Forsythe,	Butler.
James H. Fones,	Tionesta.
Wister, Hacker & Savage,	Germantown.
W. J. Thompson & Co.,	Clifton Heights.
Steward M. Dreher,	Stroudsburg.
State Normal School,	Millersville.
E. C. Wagner,	Girardville.
Hartford P. Brown,	Rochester.
L. H. Grenewald,	York.
J. E. Pague,	Carlisle.
C. L. Peck,	Coudersport.
H. D. Miller,	Drifton.

PENNSYLVANIA STATE WEATHER SERVICE.

MONTHLY WEATHER REVIEW

FOR JUNE, 1888.

Prepared under the Direction of the Committee on Meteorology of the FRANKLIN INSTITUTE.

HALL OF THE FRANKLIN INSTITUTE,

PHILADELPHIA, June 30, 1888.

TEMPERATURE.

The mean temperature for June, 1888, as deduced from the observations of more than fifty stations, gives 68°·6, which is probably 1° above the average.

The departures from the June normals (fifteen years) at the Signal Service Stations show the following: Erie, 0°·0; Pittsburgh + 1°·0; Philadelphia, + 1°·5. The mean of the daily maximums at fifty stations, 80°·7, and the mean of the daily minimums, 56°·1, give an average, or mean, of 68°·4, which very nearly corresponds with that determined from the tri-daily readings.

The highest temperatures prevailed on the 21st, but they were not unusual for the season. The highest June temperatures for the past fifteen years give an average at Erie, Pittsburgh and Philadelphia of 87°·7, 94°·0 and 92°·5, respectively, against 87°·5, 95°·2 and 97°·2 during June, 1888. Lock Haven reports 100°; Chambersburg, 99°·5; Reading, 99°; Catawissa, 99°; Carlisle, 99°, and Montrose, 99°.

The lowest temperatures noted were Coudersport, 30°; Somerset, 31°, Columbus, 32°; Dyberry, 32°, and Honesdale, 32°. Most of the low temperatures occurred on the 4th, with frosts at many places. At the close of June, the season was less than one week late.

ATMOSPHERIC PRESSURE.

The barometer was normal with slight fluctuations, ranging but little over half an inch.

PRECIPITATION.

There was a rainfall deficiency of about one inch. The total average throughout the State was 3·04 inches, but, owing to its unequal distribution, several sections had a large deficiency, and a few an excess, caused by heavy local storms. In many parts rain was needed during the first three weeks of the month, but copious showers fell in all districts during the last week, which favorably affected all growing crops. The extremes of rainfall reported were: Coudersport, 6·90 inches; Emporium, 6·57 inches; Girardville, 6·50 inches; Pottstown, 1·55 inches; Bernice, 1·15 inches; Phillipsburg, 1·11 inches, and Philadelphia, 1·08 inches.

Average number.—Rainy days, 9; clear days, 12; fair days, 11; cloudy days, 7.

Prevailing direction of wind, 7 A. M., northwest; 2 P. M., southwest; 9 P. M., southwest.

MISCELLANEOUS PHENOMENA.

Thunder Storms.—Rochester, 9th, 10th, 14th; Charlesville, 6th, 9th, 10th, 14th, 16th, 18th, 21st, 22d, 23d; Reading, 10th, 18th, 21st, 22d, 23d; Kutztown, 10th, 14th, 15th, 16th, 18th, 21st, 23d; Johnstown, 6th, 10th, 14th, 15th, 20th, 21st, 23d, 24th; Emporium, 2d, 10th, 14th, 15th, 21st, 23d, 24th; State College, 21st; West Chester, 16th, 23d; Coatesville, 14th, 16th, 21st, 23d; Clarion, 6th, 14th, 15th, 21st, 22d, 23d; Grampian Hills, 2d, 11th, 23d, 24th, 28th; Catawissa, 21st, 23d, 24th; Carlisle, 10th, 14th, 15th, 16th, 21st, 23d; Swarthmore, 16th, 23d; Erie, 2d, 10th, 14th, 15th, 21st, 22d, 23d; Uniontown, 6th, 14th, 22d, 24th, 26th, 29th; Tionesta, 15th; McConnellsburg, 21st; Huntingdon, 24th; Indiana, 2d, 6th, 10th, 15th, 21st, 24th, 27th, 28th; Scranton, 2d, 15th, 21st, 23d, 24th; Lancaster, 16th, 23d, 28th; New Castle, 9th, 10th, 14th; Lebanon, 10th, 23d; Drifton, 21st, 23d; Greenville, 10th, 14th, 15th, 22d, 23d, 24th; Stroudsburg, 14th, 15th, 23d, 24th; Bethlehem, 10th, 14th, 15th, 16th, 18th, 21st, 23d; Shamokin, 24th; New Bloomfield, 15th, 16th, 21st, 23d; Philadelphia, 16th, 23d; Blooming Grove, 15th, 18th, 23d, 24th, 30th; Coudersport, 6th, 10th, 14th, 15th, 16th, 21st, 22d, 23d, 24th; Girardville, 21st, 23d, 24th; Somerset, 15th, 21st, 24th; Eagles Mere, 10th, 14th, 15th, 21st, 23d; Bernice, 7th, 15th, 21st, 22d, 23d, 26th; Montrose, 6th, 23d, 24th; Wellsboro, 2d, 10th, 14th, 15th, 21st, 22d, 23d, 24th; Franklin, 14th, 15th, 21st, 22d, 23d, 24th; Columbus, 10th, 14th, 21st, 22d, 23d, 24th; Dyberry, 15th, 24th, 30th.

Hail.—Quakertown, 16th; Johnstown, 6th; Coatesville, 16th; Carlisle, 23d; Tionesta, 15th; Scranton, 15th; Greenville, 2d; New Bloomfield, 16th; Blooming Grove, 15th; Coudersport, 2d; Franklin, 15th.

Frosts.—Pittsburgh, 4th; Rochester, 4th; Charlesville, 3d; Wysox, 4th; Johnstown, 4th; Coatesville, 4th; Grampian Hills, 4th; Catawissa, 4th;

Monthly Summary of Reports by Voluntary Observers of the Pennsylvania State Weat

County.	Station.	Elevation above Sea Level (feet).	Barometer.			Temperature.											Relative Humidity.	Dew Point.
						Maximum.			Minimum.				Daily Range.					
			Mean.	Highest.	Lowest.	Mean.	Highest.	Date.	Lowest.	Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.	
Allegheny,	Pittsburgh,	847	29·936	30·240	29·720	71·8	95·2	20	41·4	3	82·4	61·4	21·0	30·7	5, 20	9·3	29	63·7	57·6
Beaver,	Rochester,	821	. . .	. . .	. . .	66·7	94·0	20, 21	37·0	4	81·2	56·5	24·7	37·0	5, 20	8·0	29	86·6	63·6
Bedford,	Charlesville,	1,300	. . .	. . .	. . .	67·1	93·5	21	34·0	3	79·6	53·2	26·4	42·5	5	5·0	28	75·1	58·4
Berks,	Reading,	292	. . .	. . .	. . .	72·1	99·0	21	51·7	29	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Berks,	Kutztown—Keystone State Normal School,	540	. . .	. . .	. . .	69·8	94·5	18	52·0	29	80·5	63·1	17·4	26·2	20	4·5	7	. . .	. . .
Blair,[4]	Altoona,	1,181	30·180	30·420	30·000	78·2	97·0	23, 24	41·0	3	83·2	59·5	23·7	34·0	7	14·0	29	54·1	60·0
Blair,	Hollidaysburg,	947	. . .	. . .	. . .	79·7	98·0	20, 21	35·0	3, 4	84·0	53·1	30·9	49·0	5	9·0	28	81·0	64·0
Bradford,	Wysox,	718	. . .	. . .	. . .	67·6	93·5	23	35·5	4	80·2	54·3	25·9	38·6	5	11·3	28	74·9	58·2
Bucks,	Quakertown,	536	29·940	30·310	29·740	68·4	97·0	23	41·5	2	82·0	54·8	27·2	38·5	20	14·5	28	77·9	61·7
Butler,	Butler,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cambria,	Johnstown,	1,184	. . .	. . .	. . .	67·7	96·0	19, 20	38·0	4	83·9	56·9	27·0	40·0	19	7·0	29	70·8	57·7
Cameron,	Emporium,	1,030	. . .	. . .	. . .	72·0	96·0	21	35·0	4	82·4	52·7	29·7	44·0	5	11·0	29	64·0	58·5
Centre,	State College—Agricultural Experiment Station,	1,191	29·964	30·320	29·683	68·8	95·0	21	38·5	4	78·6	56·1	22·5	35·0	4	8·0	7	70·6	59·4
Centre,	Phillipsburg,	1,350	. . .	. . .	. . .	64·8	95·0	21	35·0	3	87·0	42·5	44·5	40·0	15	8·0	30	. . .	. . .
Chester,	West Chester,	455	29·942	30·245	29·715	70·6	94·5	23	49·0	3, 4	80·7	60·5	20·2	29·0	6	9·0	29	65·0	58·4
Chester,	Coatesville,	380	. . .	. . .	. . .	69·5	97·0	23	43·0	2, 4	82·8	56·5	26·3	37·5	6	10·5	29	. . .	. . .
Clarion,	Rimersburg,	1,500	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Clarion,	Clarion—State Normal School,	1,530	. . .	. . .	. . .	65·4	90·0	21	34·0	4	79·2	53·5	25·7	39·0	8	12·0	26	75·6	57·3
Clearfield,	Grampian Hills,	1,450	. . .	. . .	. . .	67·3	94·0	18	38·0	4	78·4	57·4	21·0	34·0	12	4·0	7	. . .	. . .
Clinton,	Lock Haven,	560	. . .	. . .	. . .	69·8	100·0	21	41·0	2	82·0	54·8	27·2	41·0	5	5·0	7	. . .	. . .
Columbia,	Catawissa,	491	. . .	. . .	. . .	73·2	99·0	21	40·0	4	83·5	59·3	24·2	38·0	17	5·0	28	68·7	64·2
Crawford,	Meadville—Allegheny College,	1,050	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cumberland,	Carlisle,	480	. . .	. . .	. . .	71·3	99·0	21	51·5	3	89·9	63·8	19·1	31·5	5	5·8	28	83·7	66·3
Delaware,	Swarthmore—Swarthmore College,	190	29·941	30·227	29·739	70·3	95·7	23	47·8	2	81·3	59·8	21·5	32·1	20	10·2	29	70·4	60·0
Elk,	Ridgway,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Erie,	Erie,	681	29·940	30·250	29·620	67·1	87·5	9	43·7	8	74·8	58·6	16·2	29·0	5	8·1	28	67·0	55·0
Fayette,	Uniontown,	1,000	29·938	30·191	29·710	72·3	90·0	20	38·0	3	80·5	60·9	19·6	37·0	5	5·0	29	78·5	64·8
Forest,	Tionesta,	1,058	. . .	. . .	. . .	64·2	93·0	21	35·0	4	81·4	67·8	13·6	30·0	5	15·0	2	80·0	57·0
Franklin,[3]	Chambersburg—Wilson Female College,	618	29·973	30·230	29·812	64·8	99·5	22	41·0	4	83·3	54·7	28·6	46·0	14	9·0	28	. . .	. . .
Fulton,	McConnellsburg,	875	. . .	. . .	. . .	69·0	97·0	18, 21	40·0	4, 5	82·8	55·6	27·2	38·0	6	7·0	28	73·7	60·0
Huntingdon,	Huntingdon—The Normal College,	650	. . .	. . .	. . .	68·1	98·9	21	36·0	3	84·0	51·1	32·9	42·5	5	11·0	30	81·9	62·2
Indiana,	Indiana—State Normal School,	1,350	. . .	. . .	. . .	67·6	94·0	22	35·0	3, 4	80·5	54·9	25·6	37·0	4, 9	5·0	28	79·2	61·1
Lackawanna,	Scranton,	750	. . .	. . .	. . .	69·1	96·5	21	38·0	4	81·8	55·9	25·9	39·0	5	14·0	26	76·0	61·4
Lancaster,	Lancaster—Franklin and Marshall College,	413	29·949	30·253	29·747	70·5	97·0	23	41·1	4	80·2	53·6	24·6	35·2	3	14·0	29	78·8	69·2
Lawrence,	New Castle,	932	. . .	. . .	. . .	70·5	95·0	22	33·0	4	82·6	54·4	28·2	43·0	5	8·0	29	76·6	62·1
Lebanon,	Lebanon,	480	29·981	30·293	29·755	69·3	96·4	23	39·5	4	81·6	56·4	25·2	36·7	20	13·0	26	77·5	62·2
Luzerne,	Drifton—Drifton Hospital,	1,655	. . .	. . .	. . .	65·8	97·0	21	38·0	3	81·3	55·8	25·5	39·0	20	11·0	30	. . .	. . .
Lycoming,	Williamsport,	525	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
McKean,	Smethport,	. . .	. . .	. . .	. . .	64·2	92·0	21	34·0	2	76·7	48·8	27·9	43·0	8	3·0	28	. . .	. . .
Mercer,	Greenville—Thiel College,	1,000	29·867	30·124	29·659	65·6	94·0	22	35·0	4	79·5	52·3	27·2	41·0	22	9·2	29	81·2	62·2
Monroe,	Stroudsburg,	430	. . .	. . .	. . .	68·8	94·0	23	36·0	4	82·3	53·4	28·9	40·0	5	19·0	26	84·0	63·0
Montgomery,	Pottstown,	150	. . .	. . .	. . .	73·2	98·0	28	50·0	12	83·2	64·9	18·3	30·0	5	8·0	29	70·0	62·4
Northampton,	Bethlehem,	360	29,916	30,180	29,668	71·0	95·0	18	43·0	4	83·0	57·0	26·0	36·0	6	14·0	1	72·0	61·0
Northumberland,[2]	Shamokin,	733	. . .	. . .	. . .	68·0	82·0	24	36·0	4	81·0	54·0	27·0	39·0	17	14·0	29	68·0	57·0
Perry,	New Bloomfield,	400	. . .	. . .	. . .	66·5	98·0	21	38·0	4	81·5	55·0	26·5	41·0	20	9·0	28	. . .	. . .
Philadelphia,	Philadelphia,	117	29·949	30·250	29·720	72·6	97·2	23	52·2	29	83·5	63·2	20·3	27·4	14	10·8	29	63·1	58·2
Pike,	Blooming Grove,	800	. . .	. . .	. . .	69·4	98·0	22	48·0	3	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Potter,	Coudersport,	. . .	. . .	. . .	. . .	64·6	94·0	21	30·0	4	77·3	50·7	26·6	43·0	9	7·0	28	72·1	58·5
Schuylkill,	Girardville,	1,000	29·965	30·265	29·758	69·2	98·0	21	50·0	3	79·2	59·0	20·2	. . .	. . .	. . .	. . .	. . .	. . .
Snyder,	Selins Grove,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Somerset,	Somerset,	2,250	. . .	. . .	. . .	63·0	92·0	20	32·0	3	79·1	53·2	25·9	43·5	5	10·0	29	80·0	58·3
Sullivan,	Eagles Mere,	2,060	29·945	30·330	29·470	66·6	86·0	21	39·0	3	71·7	54·5	17·2	26·0	14	5·0	28	67·0	53·0
Sullivan,[1]	Bernice,	2,000	30·133	30·347	29·908	63·9	91·0	21	37·0	2	72·8	52·3	20·5	33·0	20	13·0	26, 29	77·3	58·1
Susquehanna,	Montrose,	1,656	. . .	. . .	. . .	70·6	99·0	21	45·0	4	79·0	60·2	18·8	28·0	8	4·0	17	. . .	. . .
Tioga,	Wellsboro,	1,327	29·891	30·286	29·606	65·5	94·0	21	35·0	5	79·6	54·5	25·1	18·2	5	4·2	23	71·6	65·1
Venango,	Franklin,	1,000	. . .	. . .	. . .	65·9	91·8	22	42·0	4	. . .	. . .	. . .	. . .	. . .	. . .	. . .	74·0	57·0
Washington,	Scenery Hill,	1,750	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Washington,	Washington,	1,175	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Warren,	Columbus,	1,410	. . .	. . .	. . .	65·4	98·0	20	32·0	4	79·4	51·4	28·0	52·0	17	9·0	9, 29	76·7	55·6
Wayne,	Dyberry,	1,100	. . .	. . .	. . .	63·0	91·0	21, 23	32·0	4	76·7	50·1	26·6	42·0	5	11·0	28	. . .	. . .
Wayne,	Honesdale,	1,000	. . .	. . .	. . .	63·7	89·0	23	32·0	4	75·5	51·9	23·6	35·0	4, 5	7·0	7	. . .	. . .
Westmoreland,	Greensburg,	1,075	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
York,	York,	385	. . .	. . .	. . .	70·8	98·0	21	43·0	4	83·0	57·1	25·9	43·0	21	11·0	11	70·7	60·5

[1] 28 days. [2] 25 days. [3] Observations taken at 8 A. M. and 8 P. M. [4] Observations taken at 12 Noon.

...NTARY OBSERVERS OF THE PENNSYLVANIA STATE WEATHER SERVICE FOR JUNE, 1888.

...M.	TEMPERATURE.									PRECIPITATION.		NUMBER OF DAYS.			WIND.	
			DAILY RANGE.												PREVAILING DIRE	
Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.	Relative Humidity.	Dew Point.	Total Inches.	Number of Days Rainfall.	Clear.	Fair.	Cloudy.	7 A. M.	2 P. M.
3	82·4	61·4	21·0	30·7	5, 20	9·3	29	63·2	57·6	2·22	11	5	18	7	NW	NW
4	81·2	56·5	24·7	37·0	5, 20	8·0	29	80·6	63·6	2·51	5	12	12	6	NW	NW
3	79·6	53·2	26·4	42·5	5	5·0	28	75·1	58·4	3·00	11	10	5	5	W	W
29	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .	. . .	3·33	9	12	10	8	NW	NW
29	80·5	63·1	17·4	26·2	20	4·5	7	. . .	. . .	4·25	6	17	6	7	. . .	. . .
3	83·2	59·5	23·7	34·0	7	14·0	29	54·1	60·0	2·38	11	. . .	. . .	. . .	. . .	. . .
3, 4	84·0	53·1	30·9	49·0	5	9·0	28	81·0	64·0	2·31	11	15	13	2	E	W
4	80·2	54·3	25·9	38·6	5	11·3	28	74·9	58·2	2·75	7	9	8	13	NE	NW
2	82·0	54·8	27·2	38·5	20	14·5	28	77·9	61·7	1·85	9	15	11	4	NE	SW
. .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .	. . .	. . .	. .	. . .	. . .	. . .	. . .	. . .
4	83·9	56·9	27·0	40·0	19	7·0	29	70·8	57·7	3·73	14	12	11	7	SW	SW
4	82·4	52·7	29·7	44·0	5	11·0	29	64·0	58·5	6·57	10	14	10	6	SW	SW
4	78·6	56·1	22·5	35·0	4	8·0	7	70·6	59·4	2·61	7	10	14	6	W	W
3	87·0	42·5	44·5	40·0	15	8·0	30	. . .	. . .	1·11	6	18	9	3	SW	SW
3, 4	80·7	60·5	20·2	29·0	6	9·0	29	65·0	58·4	1·79	11	21	2	7	NW	SW
2, 4	82·8	56·5	26·3	37·5	6	10·5	29	. . .	. . .	1·76	7	15	10	5	S	S
. .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .	. . .	. . .	. .	. . .	. . .	. . .	. . .	. . .
4	79·2	53·5	25·7	39·0	8	12·0	26	75·6	57·3	. . .	11	12	12	6	SW	S
4	78·4	57·4	21·0	34·0	12	4·0	7	. . .	. . .	2·30	9	10	9	11	W	SW
2	82·0	54·8	27·2	41·0	5	5·0	7	. . .	. . .	2·00	8	17	10	3	W	W
4	83·5	59·3	24·2	38·0	17	5·0	28	68·7	64·2	2·78	8	13	14	3	E	NW
. .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .	. . .	. . .	. .	. . .	. . .	. . .	. . .	. . .
3	82·9	63·8	19·1	31·5	5	5·8	28	83·7	66·3	3·25	10	14	14	2	W	W
2	81·3	59·8	21·5	32·1	20	10·2	29	70·4	60·0	1·32	3	9	10	11	NW	NW
. .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .	. . .	. . .	. .	. . .	. . .	. . .	. . .	. . .
8	74·8	58·6	16·2	29·0	5	8·1	28	67·0	55·0	2·38	11	9	16	5	S	S
3	80·5	60·9	19·6	37·0	5	5·0	29	78·5	64·8	4·65	12	19	5	6	SW	SW
4	81·4	67·8	13·6	30·0	3	15·0	2	80·0	57·0	. . .	7	. . .	. . .	. . .	S	S
4	83·3	54·7	28·6	46·0	14	9·0	28	. . .	. . .	2·37	5	11	10	9	. . .	. . .
4, 5	82·8	55·6	27·2	38·0	6	7·0	28	73·7	60·0	3·10	8	15	11	4	NW	W
3	84·0	51·1	32·9	42·3	3	11·0	30	81·9	62·2	2·85	6	13	11	6	W	W
3, 4	80·5	54·9	25·6	37·0	4, 9	5·0	28	79·2	61·1	4·60	11	10	13	7	SW	SW
4	81·8	55·9	25·9	39·0	5	14·0	26	76·0	61·4	2·75	10	12	14	4	NW	NW
4	80·2	55·6	24·6	35·2	3	14·0	29	78·8	67·2	2·56	3	9	14	7	W	W
4	82·6	54·4	28·2	43·0	5	8·0	29	76·6	62·1	3·25	11	10	11	9	SE	NW
4	81·6	56·4	25·2	36·7	20	13·0	28	77·5	62·2	2·57	10	15	11	4	SW	SW
3	81·3	55·8	25·5	39·0	20	11·0	30	. . .	. . .	4·18	4	. . .	. . .	. . .	NW	NW
. .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .	. . .	. . .	. .	. . .	. . .	. . .	. . .	. . .
2	76·7	48·8	27·9	43·0	8	3·0	28	. . .	. . .	5·02	10	10	13	7	S	W
4	79·5	52·3	27·2	41·0	22	9·2	29	81·2	60·2	3·44	15	4	15	11	SW	SW
4	82·3	53·4	28·9	40·0	5	19·0	26	84·0	63·0	3·11	9	8	21	4	SW	SW
12	83·2	64·9	18·3	30·0	3	8·0	29	70·0	62·4	1·55	3	18	8	4	W	W
4	83·0	57·0	26·0	36·0	6	14·0	1	72·0	61·0	3·12	8	13	12	6	W	W
4	81·0	54·0	27·0	39·0	17	14·0	29	68·0	57·0	1·88	5	11	10	4	W	NW
4	81·5	55·0	26·5	41·0	20	9·0	28	. . .	. . .	3·50	9	16	9	5	N	N
29	83·5	63·2	20·3	27·4	14	10·8	29	63·1	58·2	1·08	5	8	17	5	S	SW
3	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .	. . .	3·50	7	. . .	. . .	. . .	. . .	. . .
4	77·3	50·7	26·6	43·0	9	7·0	28	72·1	58·5	6·90	12	16	2	12	W	NW
3	79·2	59·0	20·2	. . .	. . .	. . .	. . .	. . .	. . .	6·50	8	12	6	12	NW	NW
. .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .	. . .	. . .	. .	. . .	. . .	. . .	. . .	. . .
3	79·1	53·2	25·9	43·5	5	10·0	29	80·0	58·3	2·76	11	12	9	9	NW	SW
3	71·7	54·5	17·2	26·0	14	5·0	28	67·0	53·0	2·69	9	6	18	6	SW	SW
2	72·8	52·3	20·5	33·0	20	13·0	26, 29	77·3	58·1	1·15	10	9	13	8	W	SW
4	79·0	60·2	18·8	28·0	8	4·0	17	. . .	. . .	1·16	7	15	5	10	NW	NW
5	79·6	54·5	25·1	18·2	5	4·2	23	71·6	65·1	3·90	13	8	10	12	N	N
4	. . .	. . .	. . .	. . .	. . .	. . .	. . .	74·0	57·0	6·53	13	5	16	9	W	W
. .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .	. . .	. . .	. .	. . .	. . .	. . .	. . .	. . .
4	79·4	51·4	28·0	52·0	17	9·0	9, 29	76·7	55·6	4·38	14	14	9	7	SW	SW
4	76·7	50·1	26·6	42·0	5	12·0	28	. . .	. . .	2·07	10	9	15	6	NW	NW
4	75·5	51·9	23·6	35·0	4, 5	7·0	7	. . .	. . .	2·39	8	. . .	. . .	. . .	. . .	. . .
. .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .	. . .	. . .	. .	. . .	. . .	. . .	. . .	. . .
4	83·0	57·1	25·9	43·0	21	11·0	11	70·7	60·5	2·23	9	20	8	2	NW	NW

T. F. TOWNSE

Wind.			
Prevailing Direction.			Observers.
7 A. M.	2 P. M.	9 P. M.	
NW	NW	NW	Oscar D Stewart, Sgt. Sig. Corps.
NW	NW	o	Hartford P. Brown, Jr.
W	W	SW	Rev. A. Thos. G. Apple.
NW	NW	S	C. M. Dechant, C.E.
. .	. . .	. . .	Prof. J. H. Rohrbach.
. .	. . .	. . .	Dr. Charles B. Dudley.
E	W	W	Prof. J. A. Stewart.
NE	NW	NW	Charles Beecher.
NE	SW	NW	J. L. Heacock.
. .	. . .	. . .	J. E. Forsythe.
SW	SW	SW	E. C. Lorentz.
SW	SW	NW	T. B. Lloyd.
W	W	W	Prof. Wm. Frear.
SW	SW	SW	L. Ray Morgan.
NW	SW	NW	Jesse C. Green, D.D.S.
S	S	S	W. T. Gordon.
. .	. . .	. . .	Rev. W. W. Deatrick, A.M.
SW	S	SW	C. M. Thomas, B.S.
W	SW	W	Nathan Moore.
W	W	w	Prof. John A. Robb.
E	NW	NW	Robert M. Graham.
. .	. .	. . .	Prof. J. H. Montgomery.
W	W	o	J. E. Pague.
NW	NW	. . .	Prof. Susan J. Cunningham.
. .	. . .	. . .	Joe Messinger.
S	S	S	Peter Wood, Sgt Sig. Corps.
SW	SW	SW	Wm. Hunt.
S	S	S	Robert L. Haslet.
. .	. .	. . .	Miss Mary A. Ricker.
NW	W	NW	Thomas F. Sloan.
W	W	W	Prof. W. J. Swigart.
SW	SW	SW	Prof. Albert E Maltby.
NW	NW	NW	T. F. Heebner, M.D.
W	W	W	A. M. Schmidt, A.B.
SE	NW	N	Wm. T. Butz.
SW	SW	SW	George W. Hayes, C.E., Ph.G.
NW	NW	NW	H. D. Miller, M.D.
. .	. . .	. . .	E. H. Baker.
S	W	SW	Armstrong & Brownell.
SW	SW	N	Prof S. H. Miller.
SW	SW	SW	N. C. Miller, M.D.
W	W	W	Charles Moore, D.D.S.
W	W	W	Lerch & Rice.
W	NW	o	G. R. Hanley.
N	N	W	Frank Mortimer.
S	SW	S	Luther M. Dey, Sgt. Sig. Corps.
. .	. . .	. . .	John Grathwohl.
W	NW	. . .	D. W. Butterworth.
NW	NW	NW	E. C Wagner.
. . .	. . .	. . .	J. M. Boyer,
NW	SW	SW	W. M. Schrock.
SW	SW	SW	E. S. Chase.
W	SW	SW	C. R. Claghorn.
NW	NW	N	A. H. Berlin.
N	N	N	H. D. Deming.
W	W	NW	Prof. N. P. Kinsley.
. . .	. . .	. . .	Jacob Gayman.
. . .	. . .	. . .	Harrison Otis.
SW	SW	SW	Wm. Loveland.
NW	NW	NW	Theodore Day.
. . .	. . .	. . .	John Torrey.
. .	. .	. .	H. S. Brunot.
NW	NW	NW	Mrs. L. H. Grenewald.

T. F. Townsend, *Sergeant Signal Corps, Assistant.*

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PRECIPITATION FOR JUNE, 1888.

Date.	Greenville.	New Castle.	Rochester.	Pittsburgh.	Columbus.	Uniontown.	Indiana.	Somerset.	Johnstown.	Grampian Hills.	Emporium.	Phillipsburg.	Hollidaysburg.	Smethport.	Altoona.	Charlesville.	State College.	Huntingdon.	McConnellsburg.	Chambersburg.	Lock Haven.	New Bloomfield.	Wellsboro.	Carlisle.	York.	Wysox.	Eagles Mere.	Bernice.	Catawissa.	Shamokin.	Girardville.	Lebanon.	Lancaster.	Drifton.	Scranton.	Reading.	Kutztown.	Pottstown.
1	..	.20	..	..	..	.12	..	..	..	..	..	..	..	..	.03	..	..	..	..	..	..	..	.20	.03	..	..	..	.07	..	..	..	..	..	..	.12	..	..	..
2	.04	..	..	.25	.38	.22	1.00	..	.27	.23	.05	.01	.17	.04	.05	.03	.30	.23	.02	.14	.01	.10	.10	.02	.03	.07	.02	.06	.06	.08	.12	.03	.03	..	..	..	..	..
3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.12	..	..	..	..	..	..	..	..	.01	..	..	..	..	..	..	..	..	..	..	..	..	..	..
4	..	.02	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
5	..	..	..	..	..	..	.20	..	.22	.04	..	..	..	..	..	..	.07	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
6	..	..	..	.01	..	..	..	..	..	..	..	.15	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
7	.09	.11	..	.01	..	.10	..	.03	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.01	..	..	..
8	.53	..	.62	.01	.45	..	.40	..	.05	.43	.76	..	..	.62	..	.19	..	..	.12	..	..	.01	.08	..	.01	.12	.11	..	.02	..	..	.36	.03	..	.24	.08	..	..
9	.01	.75	.22	.04	.02	.50	.05	.23	.17	..	..	..	.02	..	.35	.09	.20	.12	.03	..	.01	..	..	.09	..	..	..	.25	..	..	..	.01	..	..	.02	..	..	.38
10	.01	..	..	..	.07	..	..	..	..	..	.07	..	.04	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
11	.13	.53	..	..	.44	.86	.02	.13	.37	.03	.78	..	..	.30	..	..	..	..	..	..	..	..	.18	.01	.17	..	.36	..	..	..	..	..	..	..	.37	..	..	..
12	.05	..	..	..	.01	..	.62	..	.25	..	.15	..	.31	.25	.05	.12	..	..	..	..	..	..	.12	.20	..	.57	.04	.40	..	..	..	.08	.02	..	.73	..	..	..
13	..	..	..	..	..	..	..	..	..	..	..	..	..	.17	..	..	..	..	..	..	..	.09	..	..	..	..	..	..	..	..	..	..	.02	.10	..	.27	.05	..
14	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.01	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
15	..	..	..	..	..	..	..	..	.30	..	..	.04	..	.10	..	.54	.60	..	1.65	.97	..	.02	.12	..	.37	..	.08	.03	1.18	..	2.35	..	..	..	.03	.41	..	..
16	.06	..	..	.33	.01	1.10	..	.90	.23	.93	.10	2.01	..	.10	..	.83	..	..	.19	.26	..	..	.05	.16	..	..	.15	.02	..	..	..	..	..	.52	..	.09	..	..
17	.95	.08	..	.17	.52	.48	..	.05	.25	..	1.50	..	.10	..	..	..	.62	..	.04	..	.17	1.08	1.24	..	.47	.22	.91	.05	.27	..	1.56	.32	.83	1.80	.13	.66	1.86	..	..
18	.62	.12	.23	.10	.95	.02	.37	.85	.25	.30	.32	.32	.05	1.06	.74	..	..	.62	..	..	.80	.30	.70	1.00	.17	.90	.34	.22	.70	1.42	.58	..	..	1.26	.43	..	..	..
19	.01	.12	..	..	.12	..	..	..	..	..	..	..	..	..	.15	..	.04	..	..	..	..	..	.12	..	..	.48	..	..	..	..	..	.03	..	..	.25	..	..	..	..
20	.02	.10	..	..	.08	.31	.04	.04	..	.10	.13	..	..	.23	.04	.01	..	..	..	..	..	..	..	..	..	.26	.68	..	..	..	..	..	..	..	.19	..	..	..	..
21	.15	..	.48	.12	..	.41	.60	.25	.17	.25	..	.55	.23	..	.25	.78	.38	.35	.02	..	.08	..	..	.04	..	..	..	..	.25	.18	.43	.08	..	..	..	..	..	..	..
22	.09	.70	1.10	1.10	1.00	.03	.40	.73	.37	.32	.80	..	.51	.75	.54	.72	..	.30	.70	.98	.95	.92	.94	1.28	.93	.13	..	.03	.23	.05	1.20	1.36	1.57	.60	.19	1.10	1.89	1.00
23	..	.02	.12	..	.08	.07	.30	.07	.11	..	..	..	.55	..	.01	.21	..	1.20	..	..	.06	.90	.05	.45	.04	..	..	.02	.07	.15	.18	.14	..	..	..	.25	.04	.17
24	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.20	..	..	..
25	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
26	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
27	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
28	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
29	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
30	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
31	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	3.38	3.44	3.25	2.51	2.82	4.38	4.65	4.60	2.76	3.73	2.30	6.57	1.11	2.31	5.08	2.38	3.00	2.61	2.85	3.10	2.37	2.00	1.30	3.90	3.25	2.23	2.75	2.69	1.15	2.78	1.88	6.90	2.57	2.56	4.18	2.75	2.61	4.25	1.55

ION FOR JUNE, 1888.

	Eagles Mere.	Bernice.	Catawissa.	Shamokin.	Girardville.	Lebanon.	Lancaster.	Drifton.	Scranton.	Reading.	Kutztown.	Pottstown.	West Chester.	Coatesville.	Dyberry.	Honesdale.	Bethlehem.	Quakertown.	Swarthmore.	Philadelphia.	Coudersport.	Sciehltzville.	Frederick.	Otsville.	Germantown.	Smith's Corner.	Point Pleasant.	Doylestown.	Lansdale.
	..	.07	..	..	..	..	..	..	..	.12	..	..	.02	..	..	..	..	..	..	..	.10	..	..	..	..	..	.01	..	.06
7	.02	.06	.06	.08	.12	.03	.03	..	..	..	..	..	.08	.01	.05	.08	..	.07	..	..	.10	..	.04	..	..	.05	..	.10	..
	..	..	..	..	..	..	..	..	..	..	..	..	.03	..	..	..	..	.01	..	..	..	..	..	..	..	..	..	..	..
	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.40	..	.22	..	..	..	..	..	..
	..	..	..	..	..	..	..	..	..	.01	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
2	.11	..	.00	..	..	.36	.03	..	.24	.08	..	..	.09	..	.17	..	.01	.08	..	..	.60	.17	..	.16	..	.12	.08	..	..
	..	.25	..	..	..	.01	..	..	.02	..	..	.38	.03	..	..	.06	..	..	..	..	..	..	..	..	..	..	..	..	..
	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	.36	..	..	..	..	..	..	..	.37	..	..	..	..	..	.03	..	.16	.08	..	..	.60	..	.03	..	..	.05	..	..	..
7	.04	.40	..	..	.08	.02	..	..	.73	..	..	..	..	..	.40	.32	.03	..	..	..	..	..	.04	.19	..	.24	..	.19	.06
	..	..	..	..	..	.02	.10	..	..	.27	.05	..	.07	.12	..	..	..	.30	..	.06	.90	..	.04	..	.15	.54	1.11	.13	..
	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.14	.22	..	..	..	..	..	..	..	..	..	..	.12
	..	..	..	..	..	..	..	..	..	..	..	..	.01	..	..	..	..	..	..	..	..	.10	..	..	..	..	..	..	..
	..	.08	.03	1.18	..	2.35	..	..	..	.03	.41	..	..	.03	..	..	.90	..	..	..	.30	.03	..	..	..	..	..	..	..
	..	.15	.00	..	..	..	..	.32	..	.00	..	..	..	..	..	..	..	..	..	..	.70	..	..	..	..	..	..	..	..
2	.91	.05	.27	..	1.56	.32	.83	1.80	.13	.66	1.86	..	..	.05	.04	.01	.85	..	..	.21	.50	.14	..	..	.34	..	..	..	.59
0	.34	.22	.70	1.42	.58	..	..	1.26	.43	..	..	..	..	..	..	.21	..	.01	.09	..	1.10	..	..	..	..	..	..	..	..
	..	..	..	..	..	..	..	..	.25	..	..	..	..	..	.56	..	..	..	..	..	..	..	..	..	..	..	..	..	..
8	..	..	..	..	..	.03	..	..	.19	..	..	..	.05	..	.22	.12	..	..	..	..	..	..	..	..	..	..	..	..	..
6	.68	..	.25	.18	.43	.08	..	..	..	..	..	..	1.25	.04	..	..	..	..	..	.02	..	..	..	..	..	..	..	..	..
3	..	.03	.23	.05	1.20	1.56	1.57	.60	.19	1.10	1.89	1.00	.14	1.09	.30	.29	1.03	1.00	1.23	.76	.80	..	..	..	..	..	..	..
	..	.02	.07	.15	.18	.14	..	..	..	.25	.04	.17	.02	.06	.03	..	..	.08	.07	.03	.80	1.35	1.06	.88	1.06	.69	.86	1.11	.77
	..	..	..	..	..	..	..	..	.20	..	..	..	..	..	.27	.70	..	..	..	..	..	..	..	..	..	..	..	..	..
	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
5	2.69	1.15	2.78	1.88	6.50	2.57	2.56	4.18	2.75	2.61	4.25	1.55	1.79	1.76	2.07	2.39	3.12	1.85	1.32	1.08	6.90	1.79	1.45	1.23	1.55	1.69	2.00	1.53	2.10

T. F.

| | | |

Tionesta, 4th; Scranton, 4th; New Castle, 4th; Greenville, 12th; Coudersport, 2d, 4th, 5th, 12th; Somerset, 3d, 4th, 12th; Eagles Mere, 4th; Montrose, 4th; Wellsboro, 2d, 3d, 4th, 5th, 12th; Franklin, 4th; Dyberry, 4th, 5th; York, 4th; Uniontown, 3d, 4th.

Auroras.—Reading, 3d; Quakertown, 1st; State College, 3d; Coatesville. 1st; Clarion, 3d; Greenville, 7th, 10th; New Bloomfield, 6th; Eagles Mere, 5th, 27th; Bernice, 3d; Wellsboro, 12th.

Coronæ.—Rochester, 13th, 14th; Reading, 22d; Lebanon, 13th, 14th, 15th, 19th, 20th, 21st, 22d, 24th; Greenville, 13th; Somerset, 19th, 26th; Eagles Mere, 12th; Dyberry, 12th, 14th, 19th.

Solar Halos.—Charlesville, 4th, 6th, 7th, 8th, 9th, 12th, 13th, 15th, 20th; Eagles Mere, 27th; Wellsboro, 27th; Dyberry, 13th.

Lunar Halos.—Rochester, 16th; Phillipsburg, 20th, 21st; Carlisle, 13th, 14th; Somerset, 19th, 22d.

T. F. T.

WEATHER SIGNALS.

Displayman.	*Station.*
U. S. Signal Office,	Philadelphia.
Wanamaker & Brown,	"
Pennsylvania Railroad Company,	"
Continental Brewing Company,	"
Samuel Simpson,	"
B. T. Babbitt,	"
Western Meat Company,	"
Neptune Laundry,	"
Chester Oil Company,	Chester.
C. W. Burkhart,	Shoemakerville.
A. N. Lindenmuth,	Allentown.
C. B. Whitehead,	Bradford.
Capt. Geo. R. Guss,	West Chester.
Werner & Son,	Emporium.
C. E. Lenhart,	Latrobe.
Thomas F. Sloan,	McConnellsburg.
J. H. Fulmer,	Muncy.
W. T. Butz,	New Castle.
S. W. Morrison,	Oxford.
Capt. A. Goldsmith,	Quakertown.
J. L. Morrison,	Sharon.
Wm. A. Engel,	Shenandoah.
Wm. Schrock,	Somerset.
Postmaster,	Meadville.
Frank Ross,	Oil City.
Lerch & Rice,	Bethlehem.
John W. Aitken,	Carbondale.
Signal Office,	Erie.
J. R. Raynsford,	Montrose.

Displayman.	*Station.*
E. P. Wilbur & Co.,	South Bethlehem.
Agricultural Experiment Station,	State College.
Signal Office,	Pittsburgh.
E. H. Baker,	Williamsport.
New Era,	Lancaster.
State Normal School,	Clarion.
Clarion Collegiate Institute,	Rimersburg.
E. S. Chase,	Eagles Mere.
Thiel College,	Greenville.
D. G. Hurley,	Altoona.
Armstrong & Brownell,	Smethport.
J. E. Forsythe,	Butler.
James H. Fones,	Tionesta.
Wister, Hacker & Savage,	Germantown.
W. J. Thompson & Co.,	Clifton Heights.
Steward M. Dreher,	Stroudsburg.
State Normal School,	Millersville.
E. C. Wagner,	Girardville.
Hartford P. Brown,	Rochester.
L. H. Grenewald,	York.
J. E. Pague,	Carlisle.
C. L. Peck,	Coudersport.
H. D. Miller,	Drifton.
—— Curtis,	Beaver.

PENNSYLVANIA STATE WEATHER SERVICE.

MONTHLY WEATHER REVIEW

FOR JULY, 1888.

Prepared under the Direction of the Committee on Meteorology of the FRANKLIN INSTITUTE.

HALL OF THE FRANKLIN INSTITUTE,

PHILADELPHIA, July 31, 1888.

TEMPERATURE.

The mean temperature for July, determined from the tri-daily observations, was 69°.4, and from the mean maximums and mean minimums, 69°.2.

These are about 3° below the normal. At Philadelphia, the monthly deficiency of temperature was 124°, and at Pittsburgh, 113°.

The highest temperatures did not reach the average maximums, by a few degrees, and the minimums ranged about 4° below those generally recorded in July.

The extremes reported were, Charlesville, 97°; Carlisle, 96°; Huntingdon, 94°·5; Somerset, 94°·5; Quakertown, 94°; Philadelphia, 93°·8; York, 93°·5; Chambersburg, 93°·5; Reading, 93°·5, the highest; and Coudersport, 38°; Dyberry, 39°; Smethport, 39°; Wellsboro, 40°; Honesdale, 41°; New Castle, 41°; and Wysox, 41°, the lowest.

Most of the high temperatures occurred on the 4th and 7th, and the lowest on the 13th, 14th and 16th. The nights were generally cool.

ATMOSPHERIC PRESSURE.

The barometer averaged nearly ·10 above the normal, with a range of about ·50.

PRECIPITATION.

There was an average of 3·45 inches of rainfall, which is from half to three quarters of an inch below the normal. It was fairly well distributed, although a few stations report decided deparatures from the average. The greatest totals were, Uniontown, 7·10 inches; Indiana, 7·04 inches; Beaver, 5·18 inches; New Castle, 4·90 inches, and Lock Haven, 4·75 inches. The least were, Coudersport, 1·40 inches; Smethport, 1·40 inches; Drifton, 2·16 inches, and Emporium, 2·17 inches.

The heaviest amounts fell on the 8th, 9th, 18th, 19th and 27th. It was seasonably distributed throughout the month, and there were few complaints from drouth.

WIND AND WEATHER.

No heavy wind-storm passed over the state, and there were not the usual number of severe local wind storms and damages by lightning usually reported. But few hail-storms occurred. The weather was favorable for harvesting, and large hay and wheat crops were garnered in excellent condition. Farmers report the season as being unusually productive.

Average number.—Rainy days, 8; clear days, 15; fair days, 10; cloudy days, 6.

MISCELLANEOUS PHENOMENA.

Thunder-Storms.—Beaver, 24th; Charlesville, 23d, 27th; Reading, 5th, 12th, 24th; Hollidaysburg, 4th, 5th, 8th, 12th, 18th, 19th, 20th, 27th; Quakertown, 5th, 20th, 24th, 27th; Johnstown, 4th, 5th, 8th, 12th, 19th, 23d; State College, 19th; West Chester, 5th, 20th; Coatesville, 5th, 7th, 20th; Grampian Hills, 5th, 19th; Lock Haven, 9th, 18th, 19th, 27th; Catawissa, 5th, 8th, 9th, 19th, 27th, 29th; Carlisle, 20th, 27th; Uniontown, 8th, 12th, 23d; Indiana, 12th, 18th, 19th, 24th, 27th; Lancaster, 9th, 10th, 12th, 20th, 27th, 28th; New Castle, 26th; Lebanon, 27th; Drifton, 27th; Stroudsburg, 27th, 31st; Pottstown, 5th; Bethlehem, 5th; Shamokin, 5th, 12th, 27th; New Bloomfield, 27th; Philadelphia, 5th, 19th, 27th; Somerset, 4th, 5th, 8th, 19th, 23d, 27th; Eagles Mere, 5th, 20th; Wellsboro, 5th, 11th, 18th, 27th, 29th, 31st; Franklin, 11th, 17th, 19th, 31st. Dyberry, 5th, 11th, 12th, 19th, 27th, 30th, 31st; York, 27th.

Monthly Summary of Reports by Voluntary Observers of the Pennsylvania State Weath

County.	Station.	Elevation above Sea Level (feet).	Barometer.			Temperature.												Relative Humidity.	Dew Point.
							Maximum.		Minimum.				Daily Range.						
			Mean.	Highest.	Lowest.	Mean.	Highest.	Date.	Lowest.	Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.		
Allegheny,[5]	Pittsburgh,	847	30·018	30·190	29·780	71·7	90·3	4	50·5	13	82·4	62·4	20·0	27·1	25	6·3	9	66·4	59·2
Beaver,[1]	Beaver,	700	. . .	. . .	. . .	68·6	89·0	31	53·0	14	81·3	62·8	18·5	27·0	17, 31	6·0	13	77·1	63·0
Bedford,[2]	Charlesville,	1,300	. . .	. . .	. . .	67·8	97·0	4	44·0	2	81·0	54·6	26·4	36·0	25	10·0	13	64·6	63·4
Berks,	Reading,	304	30·218	30·195	29·716	72·0	93·5	5	43·0	2	83·9	58·8	25·1	40·0	2	10·2	18	76·2	63·4
Berks,	Kutztown—Keystone State Normal School,	540	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Blair,[3]	Altoona,	1,181	30·281	. . .	. . .	71·3	89·0	4, 8	50·0	13	81·9	60·6	21·3	28·0	4	14·0	19, 31	58·2	55·0
Blair,	Hollidaysburg,	947	. . .	. . .	. . .	68·7	93·0	7	44·0	2	82·7	54·0	28·7	41·0	4	12·0	9	57·0	65·0
Bradford,	Wysox,	718	. . .	. . .	. . .	68·7	90·0	31	41·0	16	80·8	53·8	27·0	39·0	16	15·5	1	71·1	59·1
Bucks,	Quakertown,	536	30·020	30·240	29·640	69·5	94·0	5	47·0	16	82·6	56·6	26·0	37·3	4	9·5	9	73·0	60·9
Butler,	Butler,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cambria,	Johnstown,	1,184	29·927	30·070	29·780	67·8	92·0	4	48·0	14	84·3	57·3	27·0	40·0	3	9·0	9	74·4	60·1
Cameron,[4]	Emporium,	1,030	. . .	. . .	. . .	71·2	90·0	4	43·0	14	82·3	52·8	29·5	38·0	16	14·0	18	70·6	61·8
Centre,	State College—Agricultural Experiment Station,	1,191	30·035	30·685	29·612	69·2	86·0	4	45·0	13	78·0	55·6	22·4	31·0	23, 25	8·0	18	73·3	61·0
Centre,	Phillipsburg,	1,350	. . .	. . .	. . .	65·6	90·0	4	46·0	14	80·5	55·0	25·5	35·0	8	14·0	12	. . .	. . .
Chester,	West Chester,	455	30·024	30·238	29·662	70·8	91·5	5	52·0	13	80·1	61·8	18·3	24·0	3	11·0	9	68·0	60·0
Chester,	Coatesville,	380	. . .	. . .	. . .	69·8	93·0	7	50·0	2, 3	82·3	58·1	24·2	33·0	3, 4	12·0	9	. . .	. . .
Clarion,	Rimersburg,	1,500	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Clarion,	Clarion—State Normal School,	1,530	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Clearfield,	Grampian Hills,	1,450	. . .	. . .	. . .	67·5	86·0	7	45·0	13	79·8	57·0	22·8	38·0	4, 28	2·0	9	. . .	. . .
Clinton,	Lock Haven,	560	. . .	. . .	. . .	70·4	93·0	4	46·0	13	82·8	56·0	26·8	39·0	16	6·0	18	. . .	. . .
Columbia,	Catawissa,	491	. . .	. . .	. . .	75·0	92·0	7	49·0	13, 16	82·5	52·5	30·0	36·0	16	12·5	9	63·9	62·0
Crawford,	Meadville—Allegheny College,	1,050	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cumberland,	Carlisle,	480	. . .	. . .	. . .	71·8	96·0	7	54·5	16	86·3	62·3	24·0	32·5	23	8·0	18	85·7	67·0
Dauphin,[5]	Harrisburg,	. . .	30·040	30·230	29·680	71·5	91·4	7	54·0	4	81·5	63·0	18·5	29·0	4	6·0	1	. . .	. . .
Delaware,	Swarthmore—Swarthmore College,	190	30·017	30·213	29·665	71·3	91·9	7	53·4	13	83·1	61·0	22·1	26·2	3	11·4	29	71·0	61·0
Elk,	Ridgway,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Erie,[5]	Erie,	681	30·030	30·200	29·700	70·0	87·0	4	52·0	12	76·9	60·7	16·2	26·0	3	6·0	9	. . .	. . .
Fayette,	Uniontown,	1,000	30·017	30·142	29·724	72·3	88·0	7, 31	56·0	13, 25	81·1	65·0	16·1	24·0	12, 25	5·0	5	79·1	65·2
Forest,	Tionesta,	1,058	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Franklin,[5]	Chambersburg—Wilson Female College,	618	30·108	30·447	29·766	69·7	93·5	7	47·0	2	83·5	57·8	25·7	36·5	25	13·0	9	80·9	64·2
Fulton,	McConnellsburg,	875	. . .	. . .	. . .	69·5	91·0	7	47·0	14	82·4	57·5	24·9	36·0	7	9·0	9	75·9	61·0
Huntingdon,	Huntingdon—The Normal College,	650	. . .	. . .	. . .	72·2	94·5	4	45·0	14	83·5	60·5	23·0	34·5	6	7·0	31	. . .	. . .
Indiana,	Indiana—State Normal School,	1,390	. . .	. . .	. . .	68·0	89·0	4	43·0	13	80·2	55·2	25·0	38·0	8	6·0	9	82·0	64·0
Lackawanna,	Scranton,	750	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Lancaster,	Lancaster—Franklin and Marshall College,	413	30·024	30·230	29·701	72·2	93·0	7	57·0	13	82·0	. . .	. . .	. . .	. . .	. . .	. . .	87·7	71·3
Lawrence,	New Castle,	932	. . .	. . .	. . .	71·7	90·0	4, 31	41·0	14	85·5	54·5	31·0	37·0	3, 25	8·0	9	81·3	65·7
Lebanon,	Lebanon,	480	30·005	30·271	29·689	70·0	90·8	7	47·9	2	82·2	57·9	24·3	33·6	25	10·7	30	81·4	64·1
Luzerne,	Drifton—Drifton Hospital,	1,655	. . .	. . .	. . .	66·0	89·0	23	46·0	13, 15	81·0	56·7	24·3	33·0	3	9·0	9	. . .	. . .
Lycoming,	Williamsport,	525	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
McKean,	Smethport,	1,500	. . .	. . .	. . .	66·6	86·5	5	39·0	15	. . .	44·7	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Mercer,	Greenville—Thiel College,	1,000	29·952	30·095	29·683	67·9	89·7	11	48·5	2	82·5	54·5	28·0	36·5	23, 25	9·4	9	83·8	63·4
Monroe,	Stroudsburg,	430	. . .	. . .	. . .	70·7	90·5	7	43·5	14	80·7	53·5	29·2	41·0	16	10·0	9	. . .	. . .
Montgomery,	Pottstown,	150	. . .	. . .	. . .	73·0	93·0	5	54·0	13	83·0	64·0	19·0	27·0	3, 25	10·0	9	73·0	65·0
Northampton,	Bethlehem,	360	29·990	30·240	29·620	73·0	90·0	5, 7	50·0	16	83·0	60·0	23·0	34·0	16	10·0	29	76·0	64·0
Northumberland,	Shamokin,	733	. . .	. . .	. . .	70·0	90·0	5	45·0	14, 16	82·0	56·0	26·0	39·0	26	11·0	9	70·0	59·0
Perry,	New Bloomfield,	400	. . .	. . .	. . .	68·3	92·0	7	45·0	14	82·3	55·8	26·5	37·0	4	9·0	9	. . .	. . .
Philadelphia,[5]	Philadelphia,	117	. . .	30·260	29·660	72·1	93·8	7	56·8	13	83·1	64·7	17·8	25·8	5	8·5	1	. . .	. . .
Potter,	Coudersport,	1,654	. . .	. . .	. . .	66·8	86·0	11, 31	38·0	16	78·7	49·1	29·6	41·0	3	11·0	12	73·0	56·3
Schuylkill,	Girardville,	1,000	30·049	30·254	29·603	69·0	89·0	8	. . .	. . .	79·4	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Snyder,	Selins Grove,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Somerset,	Somerset,	2,250	. . .	. . .	. . .	64·3	94·5	20	42·5	14	79·4	53·0	25·5	39·0	25	7·0	9	83·6	61·4
Sullivan,	Eagles Mere,	2,060	30·018	30·188	29·706	64·0	80·0	7, 31	44·0	2	72·1	55·8	16·3	24·0	2	8·0	9	72·0	55·2
Sullivan,	Bernice,	2,000	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Susquehanna,	Montrose,	1,656	. . .	. . .	. . .	72·9	89·0	5	57·0	1	80·4	65·5	14·9	27·0	13	4·0	4	. . .	. . .
Tioga,	Wellsboro,	1,327	29·978	30·229	29·536	65·6	90·0	31	40·0	16	74·6	55·9	18·7	36·2	31	8·2	15	71·6	64·4
Venango,	Franklin,	1,000	. . .	. . .	. . .	66·8	86·3	30	50·9	14	. . .	. . .	. . .	. . .	. . .	. . .	. . .	75·0	58·5
Washington,	Scenery Hill,	1,750	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Washington,	Washington,	1,175	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Warren,	Columbus,	1,410	30·043	30·275	29·818	66·0	89·0	3	37·0	13	80·3	51·6	28·7	44·0	16	4·0	12	76·7	57·0
Wayne,	Dyberry,	1,100	. . .	. . .	. . .	63·7	85·0	7	39·0	14, 16	77·3	49·9	27·4	40·0	16	9·0	9	. . .	. . .
Wayne,	Honesdale,	1,000	. . .	. . .	. . .	64·0	84·0	3	41·0	14	77·0	52·0	25·0	32·0	14, 25	9·0	9	. . .	. . .
Westmoreland,	Greensburg,	1,075	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
York,	York,	385	29·918	30·309	29·136	71·3	93·5	7	45·0	4	82·6	59·2	23·4	35·5	5	9·5	29	71·3	61·9

[1] 27 days. [2] 23 days. [3] Observations taken at 12 Noon. [4] 26 days. [5] Observations taken at 8 A. M. and 8 P. M.

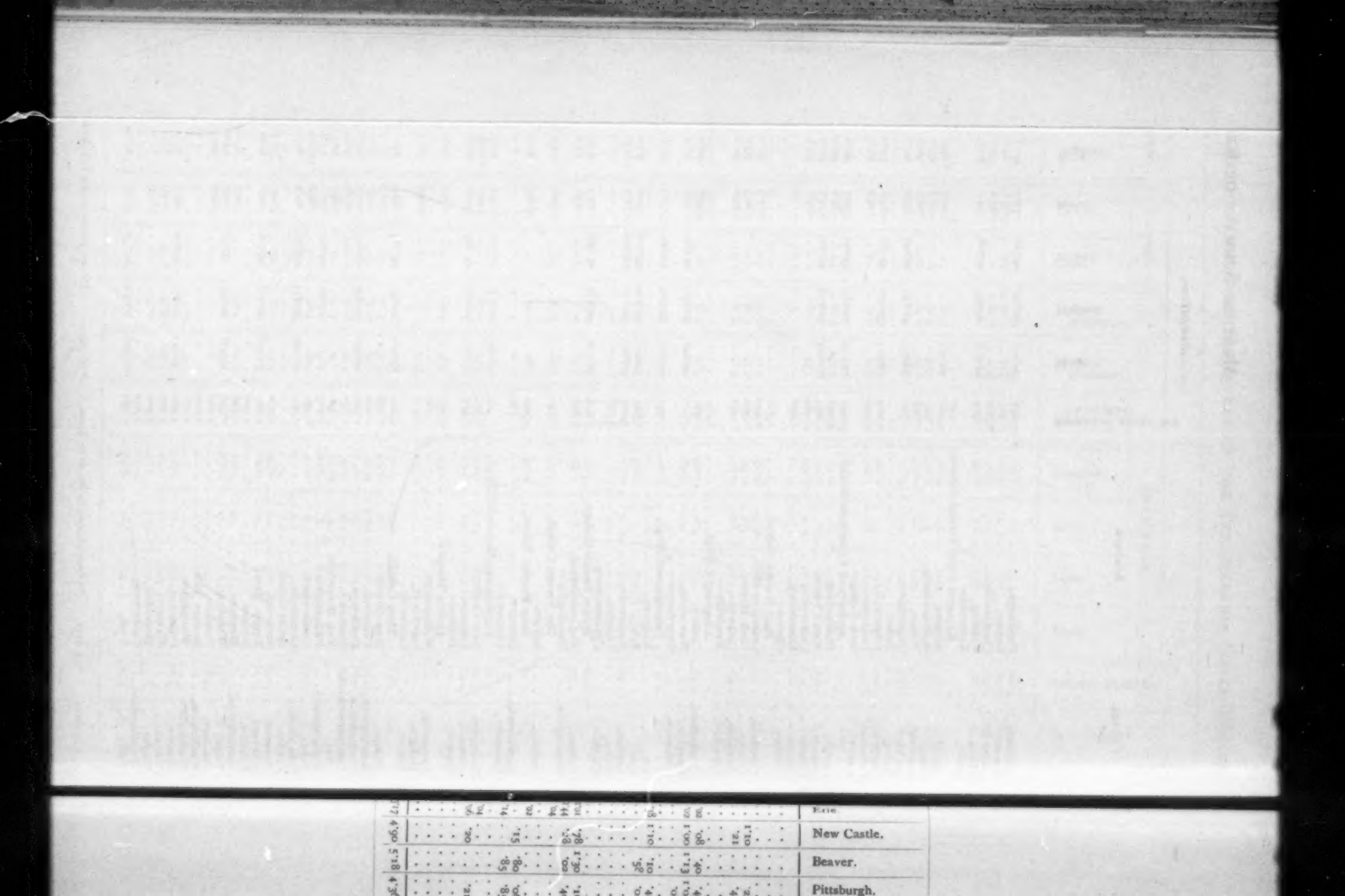
PORTS BY VOLUNTARY OBSERVERS OF THE PENNSYLVANIA STATE WEATHER SERVICE FOR

TEMPERATURE.												PRECIPITATION.		NUM
IMUM.	MINIMUM.				DAILY RANGE.									
Date.	Lowest.	Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.	Relative Humidity.	Dew Point.	Total Inches.	Number of Days Rainfall.	Clear.
4	50·5	13	80·4	60·4	20·0	27·1	25	6·3	9	66·4	59·2	4·36	11	7
31	53·0	14	81·3	62·8	18·5	27·0	17, 31	6·0	13	77·1	69·0	5·18	8	. . .
4	44·0	2	81·0	54·6	26·4	36·0	25	10·0	13	84·6	63·4	3·99	10	. . .
5	43·0	2	83·9	58·8	25·1	40·0	2	10·2	18	76·2	63·4	2·50	10	15
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
4, 8	50·0	13	81·3	60·6	21·3	28·0	4	14·0	19, 31	58·2	55·0	2·73	10	. . .
7	44·0	2	82·7	54·0	28·7	41·0	4	12·0	9	87·0	65·0	3·73	9	15
31	41·0	16	80·8	53·8	27·0	39·0	16	15·5	1	71·1	59·1	2·31	7	15
5	47·0	16	82·6	56·6	26·0	37·3	4	9·5	9	75·0	60·9	3·44	11	17
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
4	48·0	14	84·3	57·3	27·0	40·0	3	9·0	9	74·4	60·1	4·33	11	16
4	43·0	14	82·3	52·8	29·5	38·0	16	14·0	18	70·6	61·8	2·17	7	. . .
4	45·0	13	78·0	55·6	22·4	31·0	23, 25	8·0	18	73·3	61·0	2·78	6	11
4	46·0	14	80·5	55·0	25·5	35·0	8	14·0	12	. . .	. . .	4·13	10	22
5	52·0	13	80·1	61·8	18·3	24·0	3	11·0	9	68·0	60·0	4·47	13	21
7	50·0	2, 3	82·3	58·1	24·2	33·0	3, 4	12·0	9	. . .	. . .	3·91	9	18
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
7	45·0	13	79·8	57·0	22·8	38·0	4, 28	2·0	9	. . .	. . .	3·66	10	9
4	46·0	13	82·8	56·0	26·8	39·0	16	6·0	12	. . .	. . .	4·75	7	20
7	49·0	13, 16	82·5	58·5	30·0	36·0	16	12·5	9	63·9	60·0	2·48	10	15
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
7	54·5	16	86·3	60·3	24·0	32·5	23	8·0	18	85·7	67·0	3·43	10	17
7	54·0	4	81·5	63·0	18·5	29·0	4	6·0	1	. . .	. . .	3·27	8	8
7	53·4	13	83·1	61·0	22·1	26·2	3	11·4	29	71·0	61·0	2·94	8	9
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
4	52·0	12	76·9	60·7	16·2	26·0	3	6·0	9	. . .	. . .	3·17	10	. . .
7, 31	56·0	13, 25	81·1	65·0	16·1	24·0	12, 25	5·0	5	79·1	65·2	7·10	8	21
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
7	47·0	2	83·3	57·8	25·7	36·5	25	13·0	9	80·9	64·2	2·90	5	. . .
7	47·0	14	82·4	57·3	24·9	36·0	7	9·0	9	75·9	61·0	2·68	8	15
4	45·0	14	83·5	60·5	23·0	34·5	6	7·0	31	. . .	. . .	3·61	6	. . .
4	43·0	13	80·2	55·2	25·0	38·0	8	6·0	9	82·0	64·0	7·04	11	13
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
7	57·0	13	82·0	. . .	. . .	. . .	. . .	. . .	. . .	87·7	71·3	4·12	7	9
4, 31	41·0	14	85·5	54·5	31·0	37·0	3, 25	8·0	9	81·3	65·7	4·90	9	11
7	47·9	2	82·2	57·9	24·3	33·6	25	10·7	30	81·4	64·1	2·50	9	19
23	46·0	13, 15	81·0	56·7	24·3	33·0	3	9·0	9	. . .	. . .	2·16	5	. . .
. .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
5	39·0	15	. . .	44·7	. . .	. . .	. . .	. . .	. . .	. . .	. . .	1·41	9	16
11	48·5	2	82·5	54·5	28·0	36·5	23, 25	9·4	9	83·8	63·4	3·95	7	11
7	43·5	14	82·7	53·5	29·2	41·0	16	10·0	9	. . .	. . .	3·44	5	15
5	54·0	13	83·0	64·0	19·0	27·0	3, 25	10·0	9	71·0	63·0	3·31	9	22
5, 7	50·0	16	83·0	60·0	23·0	34·0	16	10·0	29	76·0	64·0	2·73	8	23
5	45·0	14, 16	80·0	56·0	26·0	39·0	26	11·0	9	70·0	59·0	2·47	6	18
7	45·0	14	82·3	55·8	26·5	37·0	4	9·0	9	. . .	. . .	2·47	4	22
7	56·8	13	83·1	64·7	17·8	25·8	5	8·5	1	. . .	. . .	3·38	10	12
11, 31	38·0	16	78·7	49·1	29·6	41·0	3	11·0	12	73·0	56·3	1·40	5	23
8	. . .	. . .	79·4	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	3·34	6	16
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
20	42·5	14	79·4	53·9	25·5	39·0	25	7·0	9	83·6	61·4	4·30	11	18
7, 31	44·0	2	72·1	55·8	16·3	24·0	2	8·0	9	72·0	55·2	3·92	11	8
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
5	57·0	1	80·4	65·5	14·9	27·0	13	4·0	4	. . .	. . .	2·38	9	15
31	40·0	16	74·0	55·9	18·7	30·2	31	8·2	15	71·6	64·4	3·50	10	12
30	50·9	14	. . .	. . .	. . .	. . .	. . .	. . .	. . .	75·0	58·5	2·77	7	8
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
3	37·0	13	80·3	51·6	28·7	44·0	16	4·0	12	76·7	57·0	2·61	12	14
7	39·0	14, 16	77·3	49·9	27·4	40·0	16	9·0	9	. . .	. . .	4·19	9	15
5	41·0	14	77·0	52·0	25·0	32·0	14, 25	9·0	9	. . .	. . .	3·75	7	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
7	45·0	1	82·6	59·2	23·4	35·5	5	9·5	29	71·3	61·9	2·84	7	20

and 8 P. M.

ITATION.	NUMBER OF DAYS.			WIND.			OBSERVERS.
				PREVAILING DIRECTION.			
Number of Days Rainfall.	Clear.	Fair.	Cloudy.	7 A. M.	2 P. M.	9 P. M.	
11	7	17	7	NW	NW	NW	Oscar D. Stewart, Sgt. Sig. Corps.
8	. . .	. . .	. . .	. . .	. . .	. . .	Smith Curtis.
10	. . .	. . .	. . .	. . .	. . .	. . .	Rev. A. Thos. G. Apple.
10	13	11	5	NW	NW	SW	C. M. Dechant, C.E.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	Prof. J. H. Rohrbach.
10	. . .	. . .	. . .	. . .	. . .	. . .	Dr. Charles B. Dudley.
9	15	11	5	W	W	W	Prof. J. A. Stewart.
7	15	6	10	NW	S	S	Charles Beecher.
11	17	7	7	NW	W	NE	J. L. Heacock.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	J. E. Forsythe.
12	16	10	5	SW	SW	SW	E. C. Lorentz.
7	. . .	. . .	. . .	W	W	W	T. B. Lloyd.
6	11	15	5	W	W	W	Prof. Wm. Frear.
10	22	5	4	SW	SW	SW	L. Ray Morgan.
13	21	6	4	N	NW	S	Jesse C. Green, D.D.S.
9	18	7	6	W	W	W	W. T. Gordon.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	Rev. W. W. Deatrick, A.M.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	C. M. Thomas, B.S.
10	9	11	11	NW	W	SW	Nathan Moore.
7	20	9	2	W	W	W	Prof. John A. Robb.
10	15	9	7	S	W	S	Robert M. Graham.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	Prof. J. H. Montgomery.
10	17	8	6	NW	W	W	J. E. Pague.
8	8	10	13	W	W	W	Frank Ridgway, Sgt. Sig. Corps.
8	9	11	11	NW	NW	. . .	Prof. Susan J. Cunningham.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	Joe Messinger.
10	. . .	. . .	. . .	NW	NW	NW	Peter Wood, Sgt. Sig. Corps.
8	21	7	3	SW	SW	SW	Wm. Hunt.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	Robert L. Haslet.
8	. . .	. . .	. . .	. . .	. . .	. . .	Miss Mary A. Ricker.
8	15	10	6	0	W	W	Thomas F. Sloan.
6	. . .	. . .	. . .	. . .	. . .	. . .	Prof. W. J. Swigart.
11	13	13	5	SW	SW	SW	Prof. Albert E Maltby.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	T. F. Heebner, M.D.
7	9	15	7	N	W	W	A. M. Schmidt, A.B.
9	11	13	7	SE	N	NE	Wm. T. Butz.
9	19	8	4	NE	SW	SW	George W. Hayes, C.E., Ph.G.
5	. . .	. . .	. . .	NW	NW	NW	H. D. Miller, M.D.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	E. H. Baker.
9	16	9	6	S	SW	SW	Armstrong & Brownell.
7	11	15	5	N	NW	N	Prof. S. H. Miller.
5	15	9	4	N	NW	NW	N. C. Miller, M.D.
9	22	5	4	W	W	SW	Charles Moore, D.D.S.
8	23	4	4	W	W	W	Lerch & Rice.
6	18	8	5	NW	S	S	G. R. Hanley.
4	22	5	4	W	N	W	Frank Mortimer.
10	12	8	11	SW	NW	NW	Luther M. Dey, Sgt. Sig. Corps.
5	23	3	5	NW	NW	. . .	C. L. Peck.
6	16	8	7	NW	NW	NW	E. C. Wagner.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	J. M. Boyer.
11	18	5	9	SW	SW	NW	W. M. Schrock.
11	8	10	7	NW	SW	NW	E. S. Chase.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	C. R. Claghorn.
9	15	5	11	NW	NW	NW	A. H. Berlin.
10	12	14	5	N	N	N	H. D. Deming.
7	8	19	4	NW	NW	NW	Prof. N. P. Kinsley.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	Jacob Gayman.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	Harrison Otis.
12	14	15	2	SW	SW	W	Wm. Loveland.
9	15	11	5	W	W	W	Theodore Day.
7	. . .	. . .	. . .	. . .	. . .	. . .	John Torrey.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	H. S. Brunot.
7	20	6	5	NW	NW	NW	Mrs. L. H. Grenewald.

T. F. TOWNSEND, *Sergeant Signal Corps, Assistant.*



PRECIPITATION FOR JULY, 1888.

Date	New Castle.	Beaver.	Pittsburgh.	Franklin.	Columbus.	Uniontown	Indiana.	Somerset.	Johnstown.	Grampian Hills	Emporium.	Phillipsburg.	Hollidaysburg.	Smethport.	Altoona.	Charlesville.	State College.	Huntingdon.	McConnellsburg.	Chambersburg.	Lock Haven.	New Bloomfield	Wellsboro.	York.	Harrisburg.	Carlisle.	Wysox.	Eagles Mere.	Catawissa.	Shamokin.	Girardville.	Lebanon.	Lancaster.	Drifton.	Montrose.	Reading.	Pottstown.	
														.02																							
	1.10		.24	.51	.42		.03	.24	.35	.03		.01	.08			.32			.05								.03	.68	.10	.45	.65			.10	.25	.19	.65	
	.21		.41		.03	1.45	.03	.36	.25	.09						.05																					
												.02			.13								.10														
.02	.08	.40	.49		.04		.22	.28	.35					.01						.41							.08	.02	.09								
.02	1.00	1.13	1.04	.13	.03	2.40	3.30	1.64	.93	.07		.25	.93	.06	.19	1.39	.85	1.45	.84	.69	.23	.70	.05	1.60	1.40	1.04			.22	.49	.72	.85	1.45	.38	.06	.62	1.00	1
			.07			.03	.04	.08	.02	.58	.04	.53	.05		.58	.17	.15	17	.14		.06	.20		.52	.20	1.40			.06	.06		.22	.70		.08	.50	.20	
														.06									.08											.04			
.38	1.10	.10	.42	1.28	.45	1.07	1.70	.50	.95	1.08	.30		.87	.20	.20	.01	.75	.78	.33		.31	.80	.04	.43	.39	.03	.04	.31	.32	.23	.22	.51	.50	.12		.27	.32	
		.58	.01									.01			.73	.57		.13	.05					.01	.25	.38										
												1.15																									
.01	.78	1.30	.16	.40	.48		.30	.09	.20	.35	.55	.02	.11	.39	.02	.43	.04		.28	.44	1.50	.08	.92			.01	.36	.31	.0								
.44	.28	.02	.40	.01	.02	1.07	.52	.61	.58	1.02	.09	1.66	.81		.60	.38	.92	.88	.56	.61	1.93	.40	1.68	.08	.40	.44	.78	1.40	.74	.83	1.42	.63	.10	.96	1.14	.28	.25	
.04					.03		.20	.23			.04	.34	.34		.08						.07	.05		.15	.18	.05		.13			.07	.06	.57			.08	.25	1
																										.02											
.02																																					
	.15	.80	.06		.87	.98		.10	.48				.03	.25		.03							.05												.10	.05	
.14		.85	.85			.07	.25		.11																							.01			.05	.02	
.04				.08	.04							.01															.01	.62	.02								
.06	.20		.21	.36	.20	.03	.45	.21	.11	.40	.23	.13	.51	.40	.15	.64	.07	.20	.43	.75	.65	.24	.50	.05	.15	.05		.32	.44	.41	.26	.15	.25	.60	.07	.21	.57	
															.05											.02							.55					
										.04																		.04					.01					
											.92			.02									.08				1.01	.06							.20	.20		
																																			.23			
																																			.31			
.17	4.90	5.18	4.36	2.77	2.61	7.10	7.04	4.30	4.33	3.66	2.17	4.13	3.73	1.41	2.73	3.99	2.78	3.61	2.68	2.90	4.75	2.47	3.50	2.84	3.26	3.43	2.31	3.92	2.48	2.47	3.34	2.50	4.12	2.16	2.38	2.50	3 31

PRECIPITATION FOR JULY, 1888.

	New Bloomfield.	Wellsboro.	York.	Harrisburg.	Carlisle.	Wysox.	Eagles Mere.	Catawissa.	Shamokin.	Girardville.	Lebanon.	Lancaster.	Drifton.	Montrose.	Reading.	Pottstown.	West Chester.	Coatesville.	Dyberry.	Honesdale.	Bethlehem.	Quakertown.	Swarthmore.	Philadelphia.	Stroudsburg.
	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	·04	·07	. .	. .	. .	. .	. .
	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	·46	. .	. .	. .	. .
	. .	·10	. .	. .	. .	·03	·68	·10	·45	·65	. .	. .	·10	·25	·19	·65	·39	·90	·06	·24	. .	·14	·09	·05	. .
	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	·07	. .	. .	. .
	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	·06	. .	. .	. .	. .	. .	. .	·01	. .	. .	. .	. .	. .	. .	. .
73	·70	·05	1·60	1·40	1·04	·08	·02	·09	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	·25	. .	. .	. .	. .
76	·20	. .	·52	·20	1·40	. .	. .	·22	·49	·72	·85	1·45	·38	·06	·62	1·00	1·07	·88	·12	·11	·39	·85	·44	1·00	. .
	. .	·08	. .	. .	. .	. .	. .	·06	·06	. .	·22	·70	. .	·08	·50	·20	·91	·72	. .	. .	. .	·18	1·29	·69	. .
71	·80	·04	·43	·59	·02	·04	·31	·32	·23	·22	·51	·50	·12	. .	27	·32	·60	·54	·05	. .	·07	·09	. .	·80	. .
	. .	. .	·01	·25	·38	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	·04	. .	. .	. .	. .	. .	·69	. .	. .
	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	·05	. .	. .
60	·08	·02	. .	. .	·01	·36	·31	·0	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
73	·40	1·68	·08	·40	·44	·78	1·40	·74	·83	1·42	·63	·10	·96	1·14	·28	·25	·07	·33	1·27	1·64	·46	·28	. .	·29	. .
67	·05	. .	·15	·18	·05	. .	·13	. .	. .	·07	·06	·57	. .	. .	·68	·25	1·10	·27	. .	. .	. .	·26	·20	. .	. .
	. .	. .	. .	. .	·02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	·03	. .	. .	. .	. .	·01	. .	. .	. .
	. .	·05	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	·10	·05	. .	. .	. .	. .	·03	. .	. .	. .	. .
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65	·24	·50	·05	·13	·05	. .	·32	·44	·41	·26	·15	·25	·60	·07	·21	·57	·17	·12	·39	·63	·98	1·45	·10	·17	2
	. .	. .	. .	. .	·02	. .	. .	. .	. .	. .	. .	·55	. .	. .	. .	. .	·03	·14	. .	. .	. .	·04	·08	·34	. .
	. .	. .	. .	. .	. .	. .	·03	·47	. .	. .	·01	. .	. .	·20	·20	. .	·03	. .	. .	. .	. .	. .	. .	·03	. .
	. .	. .	. .	. .	. .	. .	·04	. .	. .	. .	. .	. .	. .	·23	. .	. .	·02	. .	1·81	·23	. .	·07	. .	·01	. .
	. .	·08	. .	. .	. .	1·01	·06	. .	. .	. .	. .	. .	. .	·31	. .	. .	·01	. .	·37	. .	·09	. .	. .	. .	. .
75	2·47	3·50	2·84	3·26	3·43	2·31	3·92	2·48	2·47	3·34	2·90	4·12	2·16	2·38	2·50	3 31	4·47	3·91	4·19	3·75	2·73	3·44	2·94	3·38	3

Quakertown.	Swarthmore.	Philadelphia.	Stroudsburg.	Coudersport.	Scisholtzville.	Frederick.	Ottsville.	Germantown.	Smith's Corner.	Point Pleasant.	Doylestown.	Lansdale.	Forks of Neshan'y.
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·14	·09	·05	·23	. .	·08	·16	. .	·55	·25	·25	·10	·48	·18
·07	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
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·85	·44	1·00	. .	·10	. .	·70	·80	. .	. .	. .	. .	. .	. .
·18	1·29	·69	. .	.	1·09	·42	.	1·41	·99	·98	1·15	1·08	·06
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·09	.	·80	. .	·20	·15	·17	. .	·50	. .	. .	·07	. .	. .
. .	·69	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	·06
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. .	·05	. .	. .	·45	. .	. .	. .	. .	. .	. .	. .	. .	. .
·28	.	·29	·93	. .	·39	·58	·49	·34	·38	. .	. .	·29	. .
·26	·20	. .	·24	. .	. .	·18	. .	·15	·11	·75	·48	1·35	·58
·01	.	. .	. .	. .	. .	. .	. .	. .	. .	. .	·35	. .	. .
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1·45	·10	·17	2·00	·35	·85	·45	1·01	·82	1·68	1·35	·10	·04	. .
·04	·08	·34	·04	. .	. .	. .	. .	. .	. .	. .	·60	·47	2·00
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·07	. .	·01	. .	. .	. .	. .	. .	. .	·06	. .	. .	. .	·01
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3·44	2·94	3·38	3·44	1·40	2·36	2·99	2·30	4·07	3·65	3·45	2·96	4·29	2·80

T. F. T.

Hail-Storms.—Charlesville, 27th; Grampian Hills, 19th: Eagles Mere, 20th.

Frosts.—Somerset, 2d; Wellsboro, 13th, 14th, 16th.

Auroras.—Eagles Mere, 28th.

Solar Halos.—Wellsboro, 8th, 31st; Eagles Mere, 11th.

Lunar Halos.—Somerset, 17th.

Coronæ.—Indiana, 16th, Lebanon, 20th, Eagles Mere, 15th.

T. F. T.

WEATHER SIGNALS.

Displayman.	*Station.*
U. S. Signal Office,	Philadelphia.
Wanamaker & Brown,	"
Pennsylvania Railroad Company,	"
Continental Brewing Company,	"
Samuel Simpson,	"
B. T. Babbitt,	"
Western Meat Company,	"
Neptune Laundry,	"
Chester Oil Company,	Chester.
C. W. Burkhart,	Shoemakerville.
A. N. Lindenmuth,	Allentown.
C. B. Whitehead,	Bradford.
Capt. Geo. R. Guss,	West Chester.
Werner & Son,	Emporium.
C. E. Lenhart,	Latrobe.
Thomas F. Sloan,	McConnellsburg.
J. H. Fulmer,	Muncy.
W. T. Butz,	New Castle.
S. W. Morrison,	Oxford.
Capt. A. Goldsmith,	Quakertown.
J. L. Morrison,	Sharon.
Wm. A. Engel,	Shenandoah.
Wm. Schrock,	Somerset.
Postmaster,	Meadville.
Frank Ross,	Oil City.
Lerch & Rice,	Bethlehem.
John W. Aitken,	Carbondale.
Signal Office,	Erie.
J. R. Raynsford,	Montrose.
E. P. Wilbur & Co.,	South Bethlehem.
Agricultural Experiment Station,	State College.
Signal Office,	Pittsburgh.
E. H. Baker,	Williamsport.
New Era,	Lancaster.

Displayman.	*Station.*
State Normal School,	Clarion.
Clarion Collegiate Institute,	Rimersburg.
E. S. Chase,	Eagles Mere.
Thiel College,	Greenville.
D. G. Hurley,	Altoona.
Armstrong & Brownell,	Smethport.
J. E. Forsythe,	Butler.
James H. Fones,	Tionesta.
Wister, Hacker & Savage,	Germantown.
W. J. Thompson & Co.,	Clifton Heights.
Steward M. Dreher,	Stroudsburg.
State Normal School,	Millersville.
E. C. Wagner,	Girardville.
Hartford P. Brown,	Rochester.
L. H. Grenewald,	York.
J. E. Pague,	Carlisle.
C. L. Peck,	Coudersport.
H. D. Miller,	Drifton.
Smith Curtis,	Beaver.

PENNSYLVANIA STATE WEATHER SERVICE.

MONTHLY WEATHER REVIEW

FOR SEPTEMBER, 1888.

Prepared under the Direction of the Committee on Meteorology of the FRANKLIN INSTITUTE.

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, September 30, 1888.

TEMPERATURE.

The temperature for September, like that of July and August, was below the normal. At the end of the month, the season was about one week late.

The mean temperature 59°·0, determined from fifty-two stations, is 2° below the average. The highest temperatures were, Emporium, 84°; Coatesville, 84°; McConnellsburg, 84°; Lancaster, 84°; New Bloomfield, 84°, and Columbus, 84°. These occurred on the 9th and 12th. The lowest were Dyberry, 29°; Honesdale, 30°; Somerset, 30°; Bernice, 30°, and Columbus, 30°. These occurred on the 29th and 30th. The following stations report the highest mean monthly temperatures. Pottstown, 64°·3; Coatesville, 64°·6; Carlisle, 63°·7, and Catawissa, 63°·5. Lowest: Somerset, 53°·3; Phillipsburg, 53°·5; Bernice, 54°·9; Dyberry, 54°·5, and Smethport, 55°·0. Frosts were quite general on the 29th and 30th.

BAROMETER.

The mean barometer, 30·07, is very nearly normal. The highest pressures noted were on the 6th and 7th, and were about ·10 above those generally occurring during September. The lowest pressure was on the 26th, but was not unusual.

PRECIPITATION.

The average monthly rainfall for the state, was 4·84 inches, which is about 1·35 inches more than the average. It was nearly normal west of the Susquehanna River. The largest monthly totals occurred at Bethlehem, 10·93 inches; Quakertown, 9·36 inches, and Girardville, 8·18 inches. The lowest, at Pittsburgh, 1·77 inches, and Wellsboro, 1·75 inches. A number of stations reported light snow on the 29th and 30th.

WIND AND WEATHER.

The weather was generally favorable for the ripening and harvesting of corn, buckwheat and late vegetables. But little damage was done by frosts. Some delay occurred in seeding when the moisture was excessive. Winter wheat is reported as looking well. No severe gales passed over the state.

Average number.—Rainy days, 10; clear days, 8; fair days, 11; cloudy days, 11.

MISCELLANEOUS PHENOMENA.

Thunder-Storms.—Reading, 12th; Kutztown, 12th, 20th; Hollidaysburg, 12th; Quakertown, 12th, 20th; Johnstown, 12th; West Chester, 16th; Coatesville, 12th, 16th; Lock Haven, 9th; Carlisle, 12th; Lancaster, 12th, 30th; Lebanon, 20th; Greenville, 8th; Pottstown, 12th; Shamokin, 12th; New Bloomfield, 12th; Philadelphia, 13th, 16th, 20th; Somerset, 12th, 28th; Eagles Mere, 12th, 30th; Bernice, 12th; Wellsboro, 9th, 20th; Columbus, 12th, 28th, Dyberry, 12th.

Hail.—Charlesville, 28th, 29th; Johnstown, 12th; Phillipsburg, 28th; Lock Haven, 29th; Tionesta, 29th; Lancaster, 29th; Smethport, 29th, 30th; Shamokin, 29th; Girardville, 29th; Selins Grove, 13th, 28th; Eagles Mere, 29th; Bernice, 30th; Wellsboro, 29th; York, 29th.

Snow.—Johnstown, 29th; Emporium, 30th; Phillipsburg, 29th; Clarion, 29th; Grampian Hills, 28th, 29th; Tionesta, 30th; Indiana, 30th; Cornwall, 29th; Smethport, 29th, 30th; Shamokin, 29th; Girardville, 29th; Somerset, 29th; Eagles Mere, 29th, 30th; Bernice, 29th; Wellsboro, 29th, 30th; Columbus, 30th; Dyberry, 30th; Honesdale, 30th.

Frosts.—Pittsburgh, 14th; Charlesville, 14th, 30th; Wysox, 6th, 7th, 29th, 30th; Quakertown, 29th, 30th; State College, 29th; Phillipsburg, 13th, 14th; West Chester, 29th; Coatesville, 30th; Clarion, 30th; Grampian Hills, 14th, 29th; Catawissa, 14th, 28th, 29th; Carlisle, 30th; Swarthmore, 30th; Uniontown, 14th, 30th; Tionesta, 6th, 14th; McConnellsburg, 30th; Indiana, 29th, 30th; Lancaster, 29th, 30th; New Castle, 14th, 30th; Greenville, 14th; Shamokin, 29th, 30th; New Bloomfield, 29th; Philadelphia, 30th; Girardville, 29th; Selins Grove, 29th, 30th; Somerset, 14th; Eagles Mere, 29th;

COUNTY.

Allegheny,[1] . . .
Beaver, ...
Bedford, ...
Berks, ...
Berks, ...

Blair,[2] . . . . .
Blair, ...
Bradford, . . .
Bucks, ...
Butler, ...
Cambria, ...
Cameron, . . .
Centre, ...

Centre, ...
Chester, ...
Chester, ...
Clarion, ...
Clarion, ...

Clearfield, . . .
Clinton, ...
Columbia, . . .
Crawford, . . .

Cumberland, . .
Dauphin,[1] . . .
Delaware, . . .

Erie,[1] . . . . .
Fayette, ...
Forest, ...
Franklin,[1] . . .

Fulton, ...
Huntingdon, . .

Indiana, ...

Lackawanna, . .
Lancaster, . . .

Lawrence, . . .
Lebanon, ...
Luzerne, ...

McKean, ...
Mercer, ...

Monroe, ...
Montgomery, . .
Northampton,
Northumberland
Perry, ...
Philadelphia,[1]
Potter, ...
Schuylkill, . . .
Snyder, ...
Somerset, . . .
Sullivan, ...
Sullivan, . . .
Susquehanna,
Tioga, ...
Venango, . . .
Washington, .
Warren, ...
Wayne, ...
Wayne, ...
Westmoreland,
York,[1] . . .

[1] Observation

Monthly Summary of Reports by Voluntary Observers of the Pennsylvania State Weather Ser

County.	Station.	Elevation above Sea Level (feet).	Barometer.			Temperature.													Relative Humidity.	Dew Point.	Pre Total Inches.
							Maximum.		Minimum.				Daily Range.								
			Mean.	Highest.	Lowest.	Mean.	Highest.	Date.	Lowest.	Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.				
Allegheny,[1]	Pittsburgh,	847	30·066	30·380	29·960	60·2	81·2	9	39·2	30	69·6	53·6	16·0	30·3	14	6·3	1	75·7	52·0	1·77
Beaver,	Beaver,	821	. . .	. . .	. . .	58·3	81·0	4, 9	35·0	30	69·3	50·3	19·0	27·0	4, 7	8·0	20	88·5	54·5	3·20
Bedford,	Charlesville,	1,300	. . .	. . .	. . .	56·5	81·0	12	34·5	14	66·9	48·1	18·8	33·5	14	4·0	7	83·5	50·3	3·37
Berks,	Reading,	304	30·097	30·509	29·699	62·6	82·0	12	34·0	29, 30	71·2	51·6	19·6	30·0	15	7·0	17	86·3	57·6	7·57
Berks,	Kutztown— Keystone State Normal School,	540	. . .	. . .	. . .	59·5	83·0	19	35·5	29	68·8	53·3	15·5	27·0	29	5·0	9	. . .	. . .	3·95
Blair,[2]	Altoona,	1,181	. . .	. . .	. . .	61·3	79·0	10, 13	40·0	30	70·3	52·2	18·1	27·0	15	11·0	27	70·6	41·5	3·05
Blair,	Hollidaysburg,	947	. . .	. . .	. . .	59·0	83·0	12	33·0	30	70·0	46·0	24·0	36·0	14	13·0	17	91·0	57·0	1·34
Bradford,	Wysox,	718	. . .	. . .	. . .	56·7	78·4	9	33·0	30	68·2	49·6	18·6	29·0	7	10·5	1	82·8	52·3	4·40
Bucks,	Quakertown,	536	30·080	30·390	29·620	60·9	81·0	12	33·5	30	71·5	51·1	20·4	30·5	24	8·5	9, 17	84·8	56·3	9·36
Butler,	Butler,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cambria,	Johnstown,	1,184	. . .	. . .	. . .	57·2	83·0	4, 9	37·0	29, 30	70·3	50·7	19·5	33·0	14	10·0	28	81·1	40·0	4·76
Cameron,	Emporium,	1,030	. . .	. . .	. . .	59·7	84·0	4	35·0	30	70·3	46·8	23·5	37·0	4	13·0	16	77·7	42·2	2·57
Centre,	State College— Agricultural Experiment Station,	1,191	30·098	30·509	29·715	57·7	77·0	9	32·0	30	65·2	46·3	18·9	33·0	14	9·0	17	83·3	53·5	3·12
Centre,	Phillipsburg,	1,350	. . .	. . .	. . .	53·5	79·0	11	34·0	30	67·3	47·2	20·1	40·0	14	6·0	15	. . .	. . .	3·37
Chester,	West Chester,	455	30·070	30·550	29·630	62·3	81·0	12	36·0	30	69·8	55·7	14·1	23·0	12	4·0	17	78·0	44·5	7·50
Chester,	Coatesville,	380	. . .	. . .	. . .	64·6	84·0	12	34·0	30	69·8	52·8	17·0	30·0	15	7·5	17	. . .	. . .	6·99
Clarion,	Rimersburg,	1,500	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Clarion,	Clarion— State Normal School,	1,530	. . .	. . .	. . .	55·4	78·5	9	32·0	29, 30	67·5	45·4	22·1	31·0	13, 14	9·0	16	85·7	39·2	2·82
Clearfield,	Grampian Hills,	1,450	. . .	. . .	. . .	55·2	80·0	9	32·0	29	65·4	47·7	17·7	36·0	14	4·0	17	. . .	. . .	4·37
Clinton,	Lock Haven,	560	. . .	. . .	. . .	61·9	78·0	18, 19	34·0	29	68·3	48·6	19·7	29·0	15	5·0	17	. . .	. . .	4·52
Columbia,	Catawissa,	491	. . .	. . .	. . .	63·5	80·0	12	38·5	30	70·2	49·8	20·4	26·0	14	8·0	17	80·2	57·0	3·74
Crawford,	Meadville— Allegheny College,	1,050	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cumberland,	Carlisle,	480	. . .	. . .	. . .	61·7	81·5	12	42·0	30	70·2	58·7	11·5	29·0	14	4·5	11	82·0	56·6	3·29
Dauphin,[1]	Harrisburg,	. . .	30·080	30·380	29·680	60·3	80·9	12	36·5	30	68·1	55·2	12·9	22·3	12	5·0	11	81·5	52·8	4·47
Delaware,	Swarthmore— Swarthmore College,	190	30·058	30·486	29·654	61·0	81·0	8	37·0	30	72·0	56·5	15·5	25·7	15	6·1	10	79·8	56·8	6·43
Erie,[1]	Erie,	681	30·062	30·440	29·630	58·6	79·5	9	37·0	29, 30	66·6	52·1	14·5	25·0	15	6·9	1	74·8	50·1	2·86
Fayette,	Uniontown,	1,000	30·022	30·314	29·707	61·9	80·0	9	38·0	29	70·3	52·4	17·9	35·0	14	8·0	1, 7	72·3	43·0	2·84
Forest,	Tionesta,	1,058	. . .	. . .	. . .	55·7	83·0	2	32·0	29	71·9	48·1	23·8	38·0	2	9·0	30	87·2	40·7	6·40
Franklin,[1]	Chambersburg— Wilson Female College,	618	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Fulton,	McConnellsburg,	875	. . .	. . .	. . .	58·6	84·0	12	37·0	29	69·5	50·8	18·7	32·0	12, 14	8·0	11	80·0	41·0	4·03
Huntingdon,	Huntingdon— The Normal College,	650	. . .	. . .	. . .	58·7	83·5	12	34·0	29	71·7	48·5	23·2	35·7	14	12·0	17	. . .	. . .	4·13
Indiana,	Indiana— State Normal School,	1,350	. . .	. . .	. . .	57·4	81·5	9	31·5	30	68·1	47·7	20·4	35·0	14	8·0	1	82·7	52·6	2·82
Lackawanna,	Scranton,	750	. . .	. . .	. . .	61·5	78·0	12	34·0	16	73·2	47·8	25·4	34·0	26	8·0	18	81·4	55·1	5·11
Lancaster,	Lancaster— Franklin and Marshall College,	413	30·084	30·535	29·645	61·6	84·0	12	38·5	30	71·0	51·8	19·2	27·5	12, 20	8·0	17	82·5	56·1	6·02
Lawrence,	New Castle,	932	. . .	. . .	. . .	60·6	83·0	4	38·0	30	69·7	46·0	23·7	39·0	14	7·0	29	88·3	46·0	2·82
Lebanon,	Lebanon,	480	30·100	30·593	29·659	60·7	80·9	12	34·4	30	70·5	51·6	28·9	29·0	14	6·5	17	85·5	56·4	4·92
Luzerne,	Drifton— Drifton Hospital,	1,655	. . .	. . .	. . .	57·4	77·0	9, 18	35·0	29, 30	68·6	50·3	18·3	29·0	14	11·0	17	. . .	. . .	7·63
McKean,	Smethport,	1,500	. . .	. . .	. . .	55·0	79·5	11	32·0	30	68·6	43·9	24·7	40·5	15	10·0	30	79·8	36·4	3·63
Mercer,	Greenville— Thiel College,	1,000	29·985	30·519	29·554	56·7	82·2	9	32·0	14	69·5	45·4	24·1	38·2	2	13·4	7	82·8	51·5	4·07
Monroe,	Stroudsburg,	430	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Montgomery,	Pottstown,	150	. . .	. . .	. . .	64·3	81·0	12	40·0	30	71·3	56·7	14·6	24·0	14, 15	5·0	17	80·0	47·4	7·32
Northampton,	Bethlehem,	360	30·026	30·516	29·6.0	62·0	79·0	1	40·0	30	71·0	54·0	17·0	26·0	15	9·0	9, 17	83·0	57·0	10·93
Northumberland,	Shamokin,	733	. . .	. . .	. . .	58·7	81·0	12	35·0	29, 30	69·4	48·5	20·9	29·0	12	14·0	30	81·7	53·3	5·58
Perry,	New Bloomfield,	400	. . .	. . .	. . .	58·7	84·0	12	33·0	29	69·6	48·8	20·8	39·0	18	9·0	17	. . .	. . .	6·28
Philadelphia,[1]	Philadelphia,	117	30·079	30·560	29·640	63·6	81·6	20	40·5	30	73·1	58·5	14·6	24·6	8	6·1	10	73·0	56·6	5·73
Potter,	Coudersport,	1,670	. . .	. . .	. . .	56·4	79·0	5, 9	31 0	6	71·4	42·2	29·2	40·0	14	11·0	30	72·9	56·6	3·00
Schuylkill,	Girardville,	1,000	30·086	30·520	29·707	60·0	77·0	12	38·0	30	67·3	56·0	11·3	24·0	14	6·0	17	. . .	. . .	8·18
Snyder,	Selins Grove,	445	. . .	. . .	. . .	61·8	78·0	12	32·0	30	68·4	56·0	12·4	. . .	. . .	. . .	. . .	76·3	43·8	5·35
Somerset,	Somerset,	2,250	. . .	. . .	. . .	53·3	78·0	9	30·0	30	65·8	46·1	19·7	31·0	5	11·0	29	91·0	51·8	3·26
Sullivan,	Eagles Mere,	2,060	30·121	30·505	29·802	55·6	70·0	9, 18	32·0	29	61·5	48·0	13·5	26·0	6	6·0	25	84·0	51·0	6·34
Sullivan,	Bernice,	2,000	. . .	. . .	. . .	54·0	75·0	9	30·0	29	64·2	45·6	18·6	31·0	14	8·5	30	87·3	50·9	4·28
Susquehanna,	Montrose,	1,656	. . .	. . .	. . .	57·8	82·0	1	34·0	28	68·6	50·1	18·5	35·0	13	5·0	2	. . .	. . .	4·34
Tioga,	Wellsboro,	1,327	30·051	30·566	29·562	53·4	76·0	4	32·0	30	67·7	47·4	20·3	34·2	13	6·2	6	71·8	56·2	1·75
Venango,	Franklin,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Washington,	Scenery Hill,	1,750	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Warren,	Columbus,	1,410	30·084	30·324	29·807	56·3	84·0	3, 9	30·0	29, 30	69·7	42·9	26·8	46·0	14	8·0	1	82·6	48·2	4·13
Wayne,	Dyberry,	1,100	. . .	. . .	. . .	54·5	77·0	18	29·0	29, 30	65·8	46·4	19·4	33·0	25	10·0	17	. . .	. . .	6·49
Wayne,	Honesdale,	1,000	. . .	. . .	. . .	56·1	75·0	18	30·0	30	64·8	47·4	17·4	26·0	7, 15	8·0	5	. . .	. . .	7·17
Westmoreland,	Greensburg,	1,075	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
York,[1]	York,	385	30·079	30·451	29·707	61·6	83·0	12	35·0	30	71·8	53·7	18·1	27·0	14, 20	7·0	16	80·1	55·6	4·05

[1] Observations taken at 8 A. M. and 8 P. M. [2] Observations taken at 12 Noon.

TEMPERATURE.									RELATIVE HUMIDITY.	DEW POINT.	PRECIPITATION.		NUMBER OF DA		
MINIMUM.		MEAN OF MAXIMUM.	MEAN OF MINIMUM.	DAILY RANGE.											
Lowest.	Date.			Mean.	Greatest.	Date.	Least.	Date.			Total Inches.	Number of Days Rainfall.	Clear.	Fair.	
39·2	30	69·6	53·8	16·0	30·3	14	6·3	1	75·7	52·0	1·77	9	4	9	
35·0	30	69·3	50·3	19·0	27·0	4, 7	8·0	20	88·5	54·5	3·20	6	12	4	
34·5	14	66·9	48·1	18·8	33·5	14	4·0	7	83·5	50·3	5·37	9	6	14	
34·0	29, 30	71·2	51·6	19·6	30·0	15	7·0	17	86·3	59·6	7·57	12	12	3	
35·5	29	68·8	53·3	15·5	27·0	19	5·0	9	. . .	. . .	3·95	11	. . .	. . .	
40·0	30	70·3	52·2	18·1	27·0	15	11·0	27	70·6	41·5	3·05	8	. . .	. . .	
33·0	30	70·0	46·0	24·0	36·0	14	13·0	17	91·0	57·0	3·34	7	14	9	
33·0	30	68·2	49·6	18·6	29·0	7	10·5	1	82·8	52·3	4·40	8	5	9	
33·5	30	71·5	51·1	20·4	30·5	24	8·5	9, 17	84·8	56·3	9·36	14	6	11	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
37·0	29, 30	70·3	50·7	19·5	33·0	14	10·0	28	81·1	40·0	4·76	12	11	14	
35·0	30	70·3	46·8	23·5	35·0	4	12·0	16	77·7	41·2	2·37	10	10	10	
32·0	30	65·2	46·3	18·9	33·0	14	9·0	17	83·3	53·5	3·12	4	6	10	
34·0	30	67·3	47·2	20·1	40·0	14	6·0	15	. . .	. . .	3·37	12	4	19	
36·0	30	69·8	35·7	14·1	23·0	12	4·0	17	78·0	44·5	7·50	13	12	10	
34·0	30	69·8	52·8	17·0	30·0	15	7·5	17	. . .	. . .	6·99	15	10	9	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
32·0	29, 30	67·5	45·4	22·1	31·0	12, 14	9·0	16	85·7	39·2	2·82	7	6	18	
32·0	29	65·4	47·7	17·7	36·0	14	4·0	17	. . .	. . .	4·37	13	. . .	. . .	
34·0	29	68·3	48·6	19·7	29·0	15	5·0	17	. . .	. . .	4·52	9	13	7	
38·5	30	70·2	49·8	20·4	26·0	14	8·0	17	80·2	57·0	3·74	11	8	14	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
42·0	30	70·2	58·7	11·5	29·0	14	4·5	11	82·0	56·6	3·29	10	7	10	
36·5	30	68·1	55·2	12·9	22·3	12	5·0	11	81·5	52·8	4·47	12	3	12	
37·0	30	72·0	56·5	15·5	25·7	15	6·2	10	79·8	56·8	6·43	11	1	11	
37·0	29, 30	66·6	52·1	14·5	23·0	15	6·9	1	74·8	50·1	2·86	12	12	9	
38·0	29	70·3	52·4	17·9	35·0	14	8·0	1, 7	72·3	43·0	2·84	6	7	20	
32·0	29	71·9	48·1	23·8	38·0	2	9·0	30	87·2	40·7	6·40	5	5	11	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
37·0	29	69·5	50·8	18·7	32·0	12, 14	8·0	11	80·0	41·0	4·03	10	7	9	
34·0	29	71·7	48·5	23·2	35·7	14	12·0	17	. . .	. . .	4·13	11	. . .	. . .	
31·5	30	68·1	47·7	20·4	35·0	14	8·0	1	82·7	52·6	2·82	12	6	13	
34·0	26	73·2	47·8	25·4	34·0	26	8·0	18	81·4	55·1	5·11	9	13	10	
32·5	30	71·0	51·8	19·2	27·5	12, 20	8·0	17	82·5	56·1	6·02	12	7	10	
32·0	30	69·7	46·0	23·7	39·0	14	7·0	29	88·3	46·0	2·82	5	5	12	
34·4	30	70·5	51·6	28·9	29·0	14	6·5	17	85·5	56·4	4·92	11	9	11	
35·0	29, 30	68·6	50·3	18·3	29·0	14	11·0	17	. . .	. . .	7·63	10	. . .	. . .	
32·0	30	68·6	43·9	24·7	40·5	15	10·0	30	79·8	36·4	3·63	10	8	12	
32·0	14	69·5	45·4	24·1	38·2	2	13·4	7	82·8	51·5	4·07	9	6	11	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
40·0	30	71·3	56·7	14·6	24·0	14, 15	5·0	17	80·0	47·4	7·32	9	13	8	
40·0	30	71·0	54·0	17·0	26·0	15	9·0	9, 17	83·0	57·0	10·93	8	12	9	
35·0	29, 30	69·4	48·5	20·9	29·0	12	14·0	30	81·7	53·3	5·58	11	8	14	
33·0	29	69·6	48·8	20·8	39·0	18	9·0	17	. . .	. . .	6·28	11	10	4	
40·5	30	73·1	58·5	14·6	24·6	8	6·1	10	73·0	56·6	5·73	13	7	7	
31·0	6	71·4	42·2	29·2	40·0	14	11·0	30	72·9	56·6	3·00	8	13	8	
38·0	30	67·3	56·0	11·3	24·0	14	6·0	17	. . .	. . .	8·18	8	9	8	
32·0	30	68·4	56·0	12·4	. . .	. . .	. . .	. . .	76·3	43·8	5·35	10	6	16	
30·0	30	65·8	46·1	19·7	31·0	5	11·0	29	91·0	51·8	3·26	8	13	7	
32·0	29	61·5	48·0	13·5	26·0	6	6·0	25	84·0	51·0	6·34	9	5	13	
30·0	29	64·2	45·6	18·6	31·0	14	8·5	30	87·3	50·9	4·22	12	4	14	
34·0	28	68·6	50·1	18·5	35·0	13	5·0	2	. . .	. . .	4·34	8	15	7	
32·0	30	67·7	47·4	20·3	34·2	13	6·2	6	71·8	56·2	1·75	8	3	10	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
30·0	29, 30	69·7	42·9	26·8	46·0	14	8·0	1	82·6	48·2	4·13	12	6	17	
29·0	29, 30	65·8	46·4	19·4	33·0	15	10·0	17	. . .	. . .	6·49	10	6	12	
30·0	30	64·8	47·4	17·4	26·0	7, 15	8·0	5	. . .	. . .	7·17	9	. . .	. . .	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
35·0	30	71·8	53·7	18·1	27·0	14, 20	7·0	16	80·1	55·6	4·05	12	10	9	

Number of Days.			Wind.			Observers.
			Prevailing Direction.			
Clear.	Fair.	Cloudy.	7 A. M.	2 P. M.	9 P. M.	
4	9	17	NW	NW	NW	Oscar D. Stewart, Sgt. Sig. Corps.
2	4	14	W	W	W	Smith Curtis.
6	14	10	NW	W	W	Rev. A. Thos. G. Apple.
2	3	25	NW	NW	NW	C. M. Dechant, C.E.
..	....	....	....	....	....	Prof. J. H. Rohrbach.
..	....	....	....	....	....	Dr. Charles B. Dudley.
4	9	7	W	W	W	Prof. J. A. Stewart.
5	9	16	NW	NW	SW	Charles Beecher.
6	11	13	NW	NW	SW	J. L. Heacock.
..	....	....	....	....	....	J. E. Forsythe.
1	14	5	SW	SW	SW	E. C. Lorentz.
10	10	10	W	NW	W	T. B. Lloyd.
6	10	14	W	W	W	Prof. Wm. Frear.
4	19	7	SW	SW	SW	L. Ray Morgan.
2	10	8	W	NW	NW	Jesse C. Green, D.D.S.
10	9	11	W	W	W	W. T. Gordon.
..	....	....	....	....	....	Rev. W. W. Deatrick, A.M.
6	18	6	S	S	S	C. M. Thomas, B.S.
..	....	....	....	....	....	Nathan Moore.
3	7	10	W	W	W	Prof. John A. Robb.
11	14	8	E	W	S	Robert M. Graham.
..	....	....	....	....	....	Prof. J. H. Montgomery.
7	20	3	W	W	W	J. E. Pague.
3	11	16	N	NW	....	Frank Ridgway, Sgt. Sig. Corps.
1	11	18	NW	NW	....	Prof. Susan J. Cunningham.
2	9	9	S	S	S	Peter Wood, Sgt Sig. Corps.
7	20	3	NW	NW	NW	Wm. Hunt.
5	11	14	SW	SW	SW	Robert L. Haslet.
..	....	....	....	....	....	P. C. Richardson.
7	9	14	W	W	W	Thomas F. Sloan.
..	....	....	....	....	....	Prof. W. J. Swigart.
6	13	11	W	W	NW	Prof. Albert E. Maltby.
3	10	7	SE	SE	SE	J. F. Baumeister.
7	10	13	W	W	SW	A. M. Schmidt, A.B.
5	12	13	SE	NW	SE	Wm. T. Butz.
9	11	10	NE	NE	NE	George W. Hayes, C.E., Ph.G.
..	....	....	NW	NW	NW	H. D. Miller, M.D.
8	12	10	S	SW	SW	Armstrong & Brownell.
6	11	13	S	SW	N	Prof S. H. Miller.
..	....	....	....	....	....	N. C. Miller, M.D.
3	8	9	W	W	W	Charles Moore, D.D.S.
2	9	9	W	W	W	Lerch & Rice.
8	14	8	NW	W	W	G. R. Hanley.
0	4	16	W	W	W	Frank Mortimer.
7	7	16	NE	NW	....	Luther M. Dey, Sgt. Sig. Corps.
3	8	9	W	W	....	C. L. Peck.
9	8	13	NW	NW	NW	E. C Wagner.
6	16	8	SW	NW	SW	J. M. Boyer,
3	7	10	NW	NW	NW	W. M. Schrock.
5	13	12	NW	NW	SW	E. S. Chase.
4	14	12	W	SW	SW	C. R. Claghorn.
5	7	8	N	N	N	A. H. Berlin.
3	10	17	N	NW	SW	H. D. Deming.
..	....	....	....	....	....	Prof. N. P. Kinsley.
..	....	....	....	....	....	Jacob Gayman.
6	17	7	SW	SW	SW	Wm. Loveland.
6	12	12	NW	NW	NW	Theodore Day.
..	....	....	....	....	....	John Torrey.
..	....	....	....	....	....	H. S. Brunot.
10	9	11	NE	NE	....	Mrs. L. H. Grenewald.

T. F. TOWNSEND, *Sergeant Signal Corps, Assistant.*

Erie.	Greenville.	New Castle.
.03	. .	. .
. .	. .	. .
. .	. .	. .
.17	.43	. .
.37	1.18	1.56
. .	.02	. .
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. .	.07	. .
. .	. .	. .
. .	. .	. .
.40	1.50	.85
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.07	.20	.01
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. .	. .	.03
.33	.11	. .
. .	. .	. .
.34	.16	. .
.94	.37	. .
. .	. .	. .
2.86	4.07	2.82

PRECIPITATION FOR SEPTEMBER, 1888.

Erie.	Greenville.	New Castle.	Beaver.	Meadville.	Columbus.	Tionesta.	Pittsburgh.	Clarion.	Uniontown.	Indiana.	Somerset.	Johnstown.	Grampian Hills.	Emporium.	Phillipsburg.	Hollidaysburg.	Smethport.	Altoona.	Charleroi.	State College.	Huntingdon.	McConnellsburg.	Lock Haven.	New Bloomfield.	Carlisle.	Wellsboro.	York.	Harrisburg.	Selins Grove.	Wyoox.	Eagles Mere.	Bernice.	Catawissa.	Shamokin.	Girardville.	Lebanon.	Lancaster.	Dilton.	Montrose.	Reading.	Kutztown.	Scranton.
'03	..	..	..	..	..	..	..	..	.04	.12	..	.04	.90	..	..	..	..	.30	.25	..	.42	.17	.10	.05	.37	..	.03	.22	.80	..	.02	1.83	.30	.22	..	.01	.	..	..	.02	..	..
..	..	..	..	..	..	..	..	..	..	..	.06	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.01	..	.02	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
.17	.43	..	..	1.60	.45	..	.46	..	1.11	.42	.72	.72	..	.21	..	.41	.24	..	.44	..	.38	.40	.44	.33	.03	..	.26	.19	..	.60	1.16	.04	.40	.34	.72	.21	.48	.16	1.35	.17	..	..
.37	1.18	1.56	1.55	..	.90	1.50	.90	1.48	1.20	1.00	1.15	1.62	..	1.06	1.70	1.39	.76	1.34	1.05	1.21	.84	.36	1.32	2.17	1.37	.70	.68	.85	.60	.46	..	.72	.87	1.70	2.55	1.29	1.44	1.88	.20	2.02	1.35	1.7
..	.02	..	..	..	.15	..	..	..	..	..	..	.05	1.55	.02	.01	..	..	..	..	..	..	..	.74	..	..	.10	.58	..	.70	.08	..	..	..	..	..	.07	.76	.02	..	.95	.47	..
..	..	..	..	..	..	..	..	..	..	..	..	.03	..	..	..	.02	..	.14	..	..	..	..	..	.90	.10	..	.01	.01	..	..	.02	.03	.33	.50	.93	.86	.30	1.34	.65	.69	.48	.8
..	.07	..	.28	.15	.22	.40	.26	.04	..	.10	.28	1.22	..	.18	..	.39	.05	..	.19	..	.12	..	..	..	.40	.05	..	.04	..	..	.40	..	.13	.17	.42	..	.27	.34	..	1.20	.53	.5
..	..	..	..	..	..	..	..	..	.12	..	..	..	..	..	..	..	..	.07	.06	..	..	.04	..	.55	..	..	..	..	.02	..	..	..	..	.25	..	.12	..	..	..	..	..	..
..	..	..	.67	..	..	..	.01	..	..	.02	..	.15	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
.40	1.50	.85	..	.75	.65	1.20	.37	.70	.32	.75	.56	.41	.95	.58	.79	.87	..	.18	1.02	.75	.68	1.40	.37	1.15	..	.20	.55	.34	1.02	1.56	1.64	..	.45	..	.87	.38	.6	.37	.14	.32	.16	.2
..	..	..	..	..	.01	..	..	..	..	.03	.07	.08	.08	.13	.17	.17	.65	.74	.29	.44	.76	.70	.60	1.00	.40	.35	.88	1.57	1.00	1.11	1.51	.74	.45	.63	1.89	1.17	1.51	1.66	.80	1.57	.59	.9
.07	.20	.01	.07	..	.07	..	..	..	..	..	..	..	..	.05	1.11	..	.40	.06	..	..	.19	.04	..	.07	.55	..	.55	.10	..	.01	..	.67	..	..	..	.06	.32	.78	.50	.19	..	..
..	..	..	.43	.50	..	1.80	.11	.02	..	.22	..	.10	.10	..	.05	..	..	..	..	.72	.19	..	..	.01	..	.05	..	.01	1.01	.18	.23	.09	.71	.65	.57	.70	.11	.70	..	.07	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	.16	..	.16	..	..	.07	..	..	..	..	..	..	.01	..	..	..	..	..	.03	..	.87	..	..	..	..	..	..	..	..	..
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..	..	.03	..	..	.10	..	..	.04	..	.05	..	..	.03	..	.01	..	..	..	..	..	.40	.05	.07	.05	..	..	.04	.05	.01	..	..	..	.01	..	..	.05	.14	..	..	..	..	..
.33	.11	..	..	.10	.25	..	..	..	..	..	..	..	.03	..	.03	..	..	..	..	..	..	..	..	..	.04	..	.01	..	..	..	..	..	..	..	..	..	..	..	..	.31	..	..
..	..	..	..	.75	.23	..	.01	..	.05	.01	.15	.15	.10	.05	..	..	.70	.03	.05	..	.04	.04	..	..	.02	..	..	..	.01	..	..	..	..	..	..	..	..	..	..	.06	..	..
.34	.16	..	.20	.45	.20	..	.01	.12	..	.08	.27	.15	.08	.07	.20	.09	.27	.07	.07	.02	..	..	.22	..	..	.20	..	..	..	.45	.02	.07	.23	.23	..	.01	..	..	.50	..	..	..
.94	.37	..	..	1.10	.80	1.50	.04	.42	..	.02	..	..	.42	..	.13	..	.52	.05	..	..	.11	..	.06	..	..	..	.02	.01	.08	..	.95	.01	.02	.02	..	.08	.38	..	..	..	.02	..
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2.86	4.07	2.82	3.20	5.45	4.13	6.40	1.77	2.82	2.84	2.82	3.26	4.76	4.37	2.57	3.37	3.34	3.63	3.05	3.37	3.12	4.13	4.03	4.52	6.28	3.29	1.75	4.05	4.47	5.35	4.40	6.38	4.22	3.74	5.58	8.18	4.92	6.02	7.63	4.34	7.57	3.95	5.1

ECIPITATION FOR SEPTEMBER, 1888.

	Carlisle.	Wellsboro.	York.	Harrisburg.	Selins Grove.	Wysox.	Eagles Mere.	Bernice.	Catawissa.	Shamokin.	Girardville.	Lebanon.	Lancaster.	Dillon.	Montrose.	Reading.	Kutztown.	Scranton.	Pottstown.	West Chester.	Coatesville.	Dyberry.	Honesdale.	Bethlehem.	Quakertown.	Swarthmore.	Philadelphia.
5	'37	. .	'03	'22	'80	. .	'02	1'63	'30	'22	. .	'01	.	. .	. .	'02	. .	'92	. .	'24	'25	'85	1'25	. . .	'11	'07	'10
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3	'03	. .	'26	'19	. .	'60	1'16	'04	'40	'34	'72	'21	'48	'16	1'35	'17	. .	. .	'14	'15	'15	. .	. .	. .	'07	. .	'08
7	1'37	'70	'68	'85	'60	'46	. .	'72	'87	1'70	2'55	1'29	1'44	1'88	'20	2'02	1'35	1'15	'73	1'78	'75	1'46	1'44	1'36	'79	'33	'60
	. .	'10	'58	. .	'70	'08	. .	. .	. .	. .	. .	'07	'76	'02	. .	'95	'47	. .	'65	'73	'50	. .	. .	'21	'63	1'51	'97
	. .	. .	'01	'01	. .	. .	. .	'01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
0	'10	. .	'44	1'08	. .	. .	'02	'03	'33	'50	'93	'86	'30	1'34	'65	'69	'48	'89	'60	'74	'49	'56	1'42	1'86	'74	'54	'39
	'40	'05	. .	'04	. .	. .	'40	. .	'13	'17	'42	. .	'27	'34	. .	1'20	'53	'50	'50	'03	'03	'70	'06	'72	'12	'19	. .
5	. .	. .	. .	. .	'02	. .	. .	. .	. .	'25	. .	'12	. .	. .	. .	. .	. .	. .	. .	'10	'11	. .	. .	. .	'25	'11	'08
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5	. .	'20	'55	'34	1'02	1'56	1'64	. .	'45	. .	'87	'38	'6	'37	'14	'32	'16	'29	1'85	'85	2'07	'36	'73	'90	'91	'80	'66
0	'40	'35	'88	1'57	1'00	1'11	1'51	'74	'45	'63	1'89	1'17	1'51	1'66	'80	1'57	'59	'19	2'25	1'91	1'65	'85	1'76	4'70	2'72	1'63	'77
7	'55	. .	'55	'10	. .	'01	. .	'67	. .	. .	. .	'06	'32	'78	'50	'19	. .	'33	. .	'18	'35	1'37	. .	. .	'68	'15	'46
	. .	'10	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
1	. .	'05	. .	'01	1'01	'18	'23	'09	'72	'65	'57	'70	'11	'70	. .	'07	. .	'27	'35	. .	. .	'14	'26	'92	'17	. .	. .
	'01	. .	. .	. .	. .	. .	. .	'03	. .	'87	. .	. .	. .	. .	. .	. .	. .	. .	. .	'57	'34	. .	. .	. .	1'87	'88	1'39
	. .	. .	. .	. .	. .	. .	. .	'03	. .	. .	. .	. .	. .	. .	'20	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
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5	. .	. .	'04	'05	'01	. .	. .	. .	'01	. .	. .	'05	'14	. .	. .	. .	'35	. .	'25	'11	'13	. .	. .	'26	'09	. .	'06
	'04	. .	'01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	'31	. .	'07	. .	'11	'09	'20	'23	. .	'22	'22	'14
	'02	. .	. .	. .	'01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	'06	. .	. .	. .	. .	'03	. .	. .	. .	. .	. .	'03
	. .	'20	. .	. .	. .	. .	'45	'02	'07	'23	'83	. .	'01	. .	'50	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
	. .	. .	'02	'01	'08	. .	'95	'01	'02	'02	. .	. .	'08	'38	. .	. .	'08	. .	. .	. .	. .	. .	'02	. .	. .	. .	. .
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8	3'29	1'75	4'05	4'47	5'35	4'40	6'38	4'22	3'74	5'58	8'18	4'92	6'02	7'63	4'34	7'57	3'95	5'11	7'32	7'50	6'99	6'49	7'17	10'93	9'36	6'43	5'73

Quakertown.	Swarthmore.	Philadelphia.	Coudersport.	Scicholtzville.	Frederick.	Ottsville.	S.aith's Corner.	Doylestown.	Lansdale.	Forks of Nesham'y.
·11	·07	·10	·10	. .	. .	. .	. .	·34	·30	. .
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·07	. .	·08	. .	. .	. .	. .	. .	. .	. .	. .
·79	·33	·60	1·00	. .	·60	. .	. .	. .	. .	. .
·63	1·51	·97	. .	1·87	·52	1·46	1·36	. .	. .	3·11
. .	. .	. .	. .	. .	. .	. .	. .	1·81	1·76	. .
·74	·54	·39	. .	·09	·80	1·19	. .	1·10	·34	. .
·12	·19	. .	·10	·99	. .	·39	1 54	·34	·29	. .
·25	·11	·08	. .	·29	. .	. .	·44	. .	. .	1·26
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·91	·80	·66	. .	. .	·83	. .	. .	. .	. .	. .
2·72	1·63	·77	·60	. .	2·76	. .	. .	. .	. .	. .
·68	·15	·46	·30	3·13	. .	3·18	2·73	2·25	2·92	3·11
. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
·17	. .	. .	·50	1·77	. .	1·21	. .	. .	. .	. .
1·87	·88	1·39	. .	. .	·52	. .	1·51	·08	·54	·70
. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
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·09	. .	·06	. .	·30	. .	·22	. .	. .	. .	. .
·22	·22	·14	. .	. .	·26	. .	·28	. .	·26	·25
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9·36	6·43	5·73	3·00	8·35	6·36	7·65	7·86	5·87	6·49	8·43

T. F. T.

Bernice, 6th, 7th, 14th, 15th, 29th, 30th; Wellsboro, 6th, 7th, 28th, 29th, 30th; Columbus, 6th, 14th, 29th, 30th; Dyberry, 6th, 7th, 14th, 15th, 28th, 29th, 30th; Honesdale, 7th; York, 29th, 30th.

Corona.—Lancaster, 6th; Bernice, 15th, 18th, 25th.

Solar Halos.—Charlesville, 9th, 30th; Eagles Mere, 3d, 6th, 9th, 10th, 15th.

Lunar Halos.—Pittsburgh, 16th; Quakertown, 15th; Indiana, 17th.

Auroras.—Wellsboro, 26th. T. F. T.

WEATHER SIGNALS.

Displayman.	*Station.*
U. S. Signal Office,	Philadelphia.
Wanamaker & Brown,	"
Pennsylvania Railroad Company,	"
Continental Brewing Company,	"
Samuel Simpson,	"
B. T. Babbitt,	"
Western Meat Company,	"
Neptune Laundry,	"
Chester Oil Company,	Chester.
C. W. Burkhart,	Shoemakerville.
A. N. Lindenmuth,	Allentown.
C. B. Whitehead,	Bradford.
Capt. Geo. R. Guss,	West Chester.
Werner & Son,	Emporium.
C. E. Lenhart,	Latrobe.
Thomas F. Sloan,	McConnellsburg.
J. H. Fulmer,	Muncy.
W. T. Butz,	New Castle.
S. W. Morrison,	Oxford.
Capt. A. Goldsmith,	Quakertown.
J. L. Morrison,	Sharon.
Wm. A. Engel,	Shenandoah.
Wm. Schrock,	Somerset.
Postmaster,	Meadville.
Frank Ross,	Oil City.
Lerch & Rice,	Bethlehem.
John W. Aitken,	Carbondale.
Signal Office,	Erie.
J. R. Raynsford,	Montrose.
E. P. Wilbur & Co.,	South Bethlehem.
Agricultural Experiment Station,	State College.
Signal Office,	Pittsburgh.
E. H. Baker,	Williamsport.
New Era,	Lancaster.
State Normal School,	Clarion.

Displayman.	*Station.*
Clarion Collegiate Institute,	Rimersburg.
E. S. Chase,	Eagles Mere.
Thiel College,	Greenville.
D. G. Hurley,	Altoona.
Armstrong & Brownell,	Smethport.
J. E. Forsythe,	Butler.
James H. Fones,	Tionesta.
Wister, Hacker & Savage,	Germantown.
W. J. Thompson & Co.,	Clifton Heights.
Steward M. Dreher,	Stroudsburg.
State Normal School,	Millersville.
E. C. Wagner,	Girardville.
Hartford P. Brown,	Rochester.
L. H. Grenewald,	York.
J. E. Pague,	Carlisle.
C. L. Peck,	Coudersport.
H. D. Miller,	Drifton.
Smith Curtis,	Beaver.

PENNSYLVANIA STATE WEATHER SERVICE.

MONTHLY WEATHER REVIEW

FOR OCTOBER, 1888.

Prepared under the Direction of the Committee on Meteorology of the FRANKLIN INSTITUTE.

HALL OF THE FRANKLIN INSTITUTE,

PHILADELPHIA, October 31, 1888.

TEMPERATURE.

The mean temperature for the month of October was 46°·1, which is about 6° below the average, and largely increases the temperature deficiency since January 1st, which, at the close of the month at Philadelphia, amounts to 595°, or an average of nearly 2° per day for the past year.

The highest temperatures during the month were below those generally attained in October, while the lowest were about the same. The former occurred on the 1st, and most of the latter on the 10th, although several stations report other dates.

The highest recorded were, Columbus, 74°; Pittsburgh, 73°·8; Beaver, 73°; Charlesville, 73°, and New Castle, 73°. The lowest were, Clarion, 19°·2; Greenville, 20°·5; Coudersport, 21°; Dyberry, 22°, and Honesdale, 23°. The means of the daily maxima and minima from fifty stations are, respectively, 54°·7 and 38°·0. These give a mean of 46·3, which differs only two-tenths from the mean (46·1) derived from the tri-daily observations.

BAROMETER.

The range of pressure was very nearly the same that usually occurs in October, and the mean, 29·98, is about ·10 below the average.

The lowest pressure was during the warm period of the 1st, and the highest on the 26th and 31st.

PRECIPITATION.

The average rainfall over the state for the month was 4·02, which is an excess. Very few heavy rainfalls occurred, but the days on which rain fell were so numerous that the month has been unusually wet and disagreeable.

The percentage of humidity ranged high, and there was more than the usual number of cloudy days. A few snowfalls were reported, but they were light. The greatest was one inch at Somerset.

WIND AND WEATHER.

The average direction of wind was from the northwest. There were no severe gales and the prominent features of the weather were cold and wet.

Average number.—Rainy days, 16; clear days, 6; fair days, 9; cloudy days, 16.

MISCELLANEOUS PHENOMENA.

Thunder-Storms.—Beaver, 1st; Reading, 6th; Kutztown, 17th; Hollidaysburg, 19th; Quakertown, 6th, 17th; State College, 1st; Phillipsburg, 1st, 16th, 19th; West Chester, 17th, 19th; Coatesville, 17th; Rimersburg, 16th, 19th; Grampian Hills, 1st; Lock Haven, 1st, 16th, 19th; Catawissa, 19th; Carlisle, 17th; Swarthmore, 17th; Uniontown, 1st, 19th; Tionesta, 19th; McConnellsburg, 19th; Indiana, 16th, 17th; Lancaster, 6th, 17th, 19th; New Castle, 1st, 16th, 18th; Lebanon, 17th; Greenville, 19th; Pottstown, 17th; Bethlehem, 6th; New Bloomfield, 16th, 19th; Philadelphia, 17th; Coudersport, 1st; Somerset, 1st, 19th; Eagles Mere, 1st, 16th; Wellsboro, 16th; Columbus, 16th; York, 6th, 13th, 19th.

Hail.—Phillipsburg, 16th; Lock Haven, 16th; Catawissa, 11th; Indiana, 20th; Eagles Mere, 8th, 16th, 22d; Bernice, 29th; Columbus, 16th; Dyberry, 8th, 20th.

Snow.—Phillipsburg, 3d, 20th; Rimersburg, 3d, 12th, 21st; Clarion, 20th; Grampian Hills, 20th, 21st; Lock Haven, 3d; Indiana, 20th; Scranton, 3d; Greenville, 3d, 20th, 21st; Shamokin, 3d; Coudersport, 3d; Somerset, 3d, 12th, 20th; Eagles Mere, 3d, 8th, 20th, 21st, 29th; Bernice, 9th, 29th; Wellsboro, 2d, 3d, 20th; Columbus, 3d, 20th; Dyberry, 3d, 9th, 21st, 28th.

Frosts.—Pittsburgh, 4th, 29th, 10th; Beaver, 10th; Charlesville, 3d, 4th, 31st; Reading, 11th, 15th, 18th, 25th, 31st; Kutztown, 10th; Hollidaysburg, 3d, 4th, 9th, 10th, 11th, 30th, 31st; Wysox, 9th, 10th, 11th, 14th, 15th, 18th, 19th, 20th, 21st, 22d, 24th; Quakertown, 4th, 9th, 10th, 11th, 13th, 15th, 21st, 22d, 25th, 30th, 31st; State College, 3d, 4th; Phillipsburg, 3d, 4th, 10th, 11th, 20th, 25th; West Chester, 4th; Coatesville, 3d, 4th, 10th, 11th, 15th, 22d, 25th, 30th; Rimersburg, 18th; Lock Haven, 3d, 10th, 11th, 15th, 25th, 26th, 29th, 30th, 31st; Catawissa, 3d, 5th, 10th, 11th, 15th, 18th, 20th, 22d, 25th, 31st; Carlisle, 4th, 5th, 10th, 15th, 25th, 31st; Harrisburg, 4th, 15th; Swarthmore, 4th, 10th, 22d, 31st; Erie, 10th, 11th, 15th; Uniontown, 4th, 30th, 31st; McConnellsburg, 3d, 4th, 31st; Huntingdon, 3d, 4th, 11th, 22d, 25th, 30th, 31st; Indiana, 3d, 4th, 10th; Scranton, 18th; Lancaster, 3d, 4th, 10th, 15th, 18th, 22d, 25th, 30th, 31st; New Castle, 4th, 10th, 15th, 25th; Lebanon, 3d, 4th, 25th, 31st; Greenville, 10th, 11th, 15th, 25th, 30th; Pottstown, 4th, 9th, 10th, 11th, 15th, 22d; Bethlehem, 10th, 11th, 25th; New Bloomfield, 4th, 5th, 15th, 29th; Philadelphia, 4th, 10th, 31st; Coudersport, 3d, 9th, 10th, 11th; Selins Grove, 3d, 5th, 10th, 21st, 25th, 30th, 31st; Somerset, 4th, 10th, 11th, 18th, 20th, 21st, 22d, 25th, 29th, 30th, 31st; Eagles Mere, 10th, 15th, 18th,

Monthly Summary of Reports by Voluntary Observers of the Pennsylvania State Weather

County.	Station.	Elevation above Sea Level (feet).	Barometer.			Temperature.												Relative Humidity.	Dew Point.
							Maximum.		Minimum.				Daily Range.						
			Mean.	Highest.	Lowest.	Mean.	Highest.	Date.	Lowest.	Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.		
Allegheny,[1]	Pittsburgh,	847	29·982	30·350	29·480	49·0	73·8	1	32·7	10	57·1	42·5	14·6	29·4	31	5·3	21	72·8	40·8
Beaver,	Beaver,	821	. . .	. . .	. . .	46·0	73·0	1	31·0	10, 31	56·0	39·0	17·0	38·0	31	4·0	6, 13	86·0	42·0
Bedford,	Charlesville,	1,300	. . .	. . .	. . .	46·5	73·0	1	26·0	4	55·5	37·5	18·0	37·5	31	6·0	26	75·6	38·3
Berks,	Reading,	304	30·002	30·382	29·655	47·7	68·0	5	27·0	31	56·8	36·8	20·0	34·5	31	8·0	12	85·0	43·0
Berks,	Kutztown— Keystone State Normal School,	540	. . .	. . .	. . .	44·1	60·0	4	28·0	15	. . .	. . .	. . .	25·3	4	4·0	1, 23	. . .	. . .
Blair,[2]	Altoona,	1,181	. . .	. . .	. . .	49·5	72·0	2	34·0	22	57·4	41·5	15·9	29·0	3	7·0	19	69·2	40·0
Blair,	Hollidaysburg,	947	. . .	. . .	. . .	47·0	74·0	1	28·0	3, 31	57·0	37·0	20·0	44·0	31	9·0	27	90·0	44·0
Bradford,	Wysox,	718	. . .	. . .	. . .	43·8	68·5	31	25·0	11	52·2	37·6	14·6	30·5	25, 31	4·0	21	88·5	38·6
Bucks,	Quakertown,	536	30·000	30·420	29·500	45·8	63·5	1	26·0	31	55·9	36·2	19·7	34·0	31	8·5	12	83·2	40·4
Butler,	Butler,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cambria,	Johnstown,	1,184	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cameron,	Emporium,	1,030	. . .	. . .	. . .	46·7	69·0	31	26·0	11	55·3	36·7	18·6	39·0	31	9·0	14, 19	79·7	41·9
Centre,	State College— Agricultural Experiment Station,	1,191	30·020	30·384	29·485	45·5	67·0	1	29·0	10, 22	52·5	34·9	17·6	29·0	1, 31	6·0	27	81·0	39·5
Centre,	Phillipsburg,	1,350	. . .	. . .	. . .	42·5	71·0	31	27·0	10	54·6	39·5	15·1	33·0	31	3·0	12	. . .	. . .
Chester,	West Chester,	455	29·995	30·409	29·483	48·6	67·0	5	31·0	22	56·6	40·5	16·1	26·0	31	8·5	12	. . .	. . .
Chester,	Coatesville,	380	. . .	. . .	. . .	47·4	71·0	5	26·0	10	59·0	37·4	21·6	35·0	5, 31	10·0	12	. . .	. . .
Clarion,	Rimersburg,	1,500	. . .	. . .	. . .	44·0	69·0	1	30·0	10	49·9	39·4	10·5	24·0	31	6·0	20	. . .	. . .
Clarion,	Clarion— State Normal School,	1,530	. . .	. . .	. . .	44·3	68·0	25	19·2	20	52·9	34·7	17·2	31·5	31	2·0	8	81·9	38·3
Clearfield,	Grampian Hills,	1,450	. . .	. . .	. . .	43·3	68·0	31	28·0	4, 20	50·6	37·3	19·3	36·0	31	4·0	12, 13	. . .	. . .
Clinton,	Lock Haven,	560	. . .	. . .	. . .	45·8	66·0	3	25·0	25	52·9	34·5	18·4	30·0	31	5·0	28	. . .	. . .
Columbia,	Catawissa,	491	. . .	. . .	. . .	52·3	67·0	2	31·0	11	56·5	41·0	15·5	32·5	25	2·5	28	. . .	. . .
Crawford,	Meadville— Allegheny College,	1,050	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cumberland,	Carlisle,	480	. . .	. . .	. . .	49·1	69·5	1	32·0	4	57·9	42·6	15·3	31·5	5	4·0	12	76·3	42·4
Dauphin,[1]	Harrisburg,	361	30·003	30·390	29·440	47·5	69·0	2	34·9	30	55·5	42·1	13·4	27·2	5	6·4	24	75·6	39·7
Delaware,	Swarthmore— Swarthmore College,	190	30·006	30·404	29·497	49·0	66·1	5	30·3	10	57·3	40·7	16·6	27·0	19	8·7	12	75·4	41·6
Elk,	Ridgway,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Erie,[1]	Erie,	681	29·960	30·360	29·420	47·0	72·0	31	34·0	21	54·2	40·7	13·5	30·0	31	7·0	6	75·6	38·7
Fayette,	Uniontown,	1,000	29·923	30·259	29·447	50·5	71·0	1	29·0	10	58·3	41·4	16·9	34·0	31	8·0	20	76·2	48·0
Forest,	Tionesta,	1,058	. . .	. . .	. . .	44·3	71·0	31	31·0	21	57·1	39·6	17·5	37·0	31	7·0	13	85·1	40·0
Franklin,[1]	Chambersburg— Wilson Female College,	618	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Fulton,	McConnellsburg,	875	. . .	. . .	. . .	47·9	74·0	1	28·0	4	57·8	39·4	18·4	36·0	5	5·0	6	80·0	41·2
Huntingdon,	Huntingdon— The Normal College,	650	. . .	. . .	. . .	46·8	71·0	1	29·0	22, 31	56·0	37·7	18·3	40·5	31	6·0	20	. . .	. . .
Indiana,	Indiana— State Normal School,	1,350	. . .	. . .	. . .	46·3	71·5	1	26·0	10	56·2	36·0	20·2	37·0	25	4·0	13	81·0	40·6
Lackawanna,	Scranton,	750	. . .	. . .	. . .	46·4	62·0	5	31·0	15	52·9	37·4	14·5	22·0	5, 26	6·0	7	78·0	40·0
Lancaster,	Lancaster— Franklin and Marshall College,	413	30·002	30·384	29·481	48·0	68·5	5	29·5	22	57·3	38·5	18·8	31·5	31	10·0	23	75·1	41·3
Lawrence,	New Castle,	932	. . .	. . .	. . .	48·4	73·0	1	25·0	10	56·2	36·6	19·6	39·0	31	6·0	21	85·4	43·4
Lebanon,	Lebanon,	480	29·993	30·396	29·488	47·5	68·7	1	29·9	15	56·6	38·9	17·7	31·7	31	8·1	12, 23	77·6	48·1
Luzerne,	Drifton— Drifton Hospital,	1,655	. . .	. . .	. . .	44·1	65·0	5	28·0	22	55·2	35·9	19·3	30·0	31	7·0	30	. . .	. . .
Lycoming,	Williamsport,	525	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
McKean,	Smethport,	1,500	. . .	. . .	. . .	43·2	72·0	31	29·5	22	52·5	34·0	18·5	36·0	31	3·0	21	. . .	. . .
Mercer,	Greenville— Thiel College,	1,000	29·890	30·306	29·284	45·3	71·3	31	20·5	10	54·4	37·1	17·3	36·8	25	7·3	16	83·9	42·8
Monroe,	Stroudsburg,	430	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Montgomery,	Pottstown,	150	. . .	. . .	. . .	49·2	64·0	1	28·0	10	57·4	41·0	16·4	30·0	31	4·0	24	80·0	43·0
Northampton,	Bethlehem,	360	29·940	30·344	29·484	49·0	64·0	5	29·0	31	56·0	40·0	16·0	32·0	31	7·0	12, 21	84·0	44·0
Northumberland,	Shamokin,	733	. . .	. . .	. . .	46·4	66·0	1	26·0	11	56·3	36·6	19·7	36·0	31	10·0	6	78·8	41·0
Perry,	New Bloomfield,	400	. . .	. . .	. . .	45·1	70·0	1	29·0	4, 31	56·9	37·6	19·3	35·0	5	9·0	12	. . .	. . .
Philadelphia,[1]	Philadelphia,	117	29·997	30·410	29·490	50·4	69·5	3	34·8	22	58·9	44·4	14·5	24·8	31	8·4	24	71·8	41·0
Pike,	Blooming Grove,	800	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Potter,	Coudersport,	1,670	. . .	. . .	. . .	43·2	68·0	31	21·0	11	51·0	33·6	17·4	36·0	31	2·0	2	80·0	36·5
Schuylkill,	Girardville,	1,000	30·007	30·420	29·396	45·9	64·0	1	30·0	11	53·2	38·4	14·8	26·0	25, 31	7·0	6	. . .	. . .
Snyder,	Selins Grove,	445	. . .	. . .	. . .	46·7	69·0	7	31·5	15	54·6	40·0	14·6	29·5	25	4·0	12	76·7	44·0
Somerset,	Somerset,	2,250	. . .	. . .	. . .	42·9	71·0	31	26·0	4	54·2	35·0	19·2	41·0	31	7·0	26	91·1	40·8
Sullivan,	Eagles Mere,	2,060	30·018	30·382	29·704	40·5	54·0	5, 25	26·0	22	45·7	34·0	11·7	21·0	10	3·0	14	87·0	37·3
Sullivan,	Bernice,	2,000	. . .	. . .	. . .	41·1	61·0	25	27·0	3	49·0	33·7	15·3	32·0	31	4·0	14	87·0	37·9
Susquehanna,	Montrose,	1,656	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Tioga,	Wellsboro,	1,327	29·949	30·331	29·605	46·6	66·0	31	24·0	22	51·4	36·6	14·8	. . .	. . .	. . .	. . .	82·2	41·2
Venango,	Franklin,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Washington,	Scenery Hill,	1,750	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Washington,	Washington,	1,175	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Warren,	Columbus,	1,410	30·115	30·473	29·590	44·0	74·0	31	24·0	10, 11	52·3	35·8	16·5	42·0	31	2·0	20	85·4	39·0
Wayne,	Dyberry,	1,100	. . .	. . .	. . .	41·3	62·0	31	22·0	11	49·7	33·3	16·4	39·0	31	5·0	9, 21	. . .	. . .
Wayne,	Honesdale,	1,000	. . .	. . .	. . .	41·5	60·0	5	23·0	11	49·0	34·7	14·3	24·0	5, 25	4·0	9, 21	. . .	. . .
Westmoreland,	Greensburg,	1,075	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
York,[1]	York,	385	30·018	30·355	29·590	48·6	70·0	1	30·0	4	58·5	40·5	18·0	28·0	25	9·0	23, 26	75·9	40·7

[1] Observations taken at 8 A. M. and 8 P. M. [2] Observations taken at 12 Noon.

BY VOLUNTARY OBSERVERS OF THE PENNSYLVANIA STATE WEATHER SERVICE FOR OCTO

TEMPERATURE.									RELATIVE HUMIDITY.	DEW POINT.	PRECIPITATION.		NUMBER OF
MINIMUM.				DAILY RANGE.									
Lowest.	Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.			Total Inches.	Number of Days Rainfall.	Clear.	Fair.
32·7	10	57·1	42·5	14·6	29·4	31	5·3	21	72·8	40·2	3·46	18	4	7
31·0	10, 31	56·0	39·0	17·0	38·0	31	4·0	6, 13	86·0	42·0	3·08	13	10	11
26·0	4	55·5	37·5	18·0	37·5	31	6·0	26	75·6	38·3	2·52	13	. . .	. . .
27·0	31	56·8	36·8	20·0	34·5	31	8·0	12	85·0	43·0	3·77	13	12	3
28·0	15	. . .	. . .	. . .	25·3	4	4·0	1, 23	. . .	. . .	3·62	13	. . .	. . .
34·0	22	57·4	41·5	15·9	29·0	3	7·0	19	68·2	40·0	2·90	20	. . .	. . .
28·0	3, 31	57·0	37·0	20·0	44·0	31	9·0	27	90·0	44·0	3·85	16	7	11
25·0	11	52·2	37·6	14·6	30·5	25, 31	4·0	21	80·5	38·6	3·24	13	4	3
26·0	31	55·9	36·2	19·7	34·0	31	8·5	12	83·2	40·4	3·72	14	6	13
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
26·0	11	55·3	36·7	18·6	39·0	31	9·0	14, 19	79·7	41·2	4·15	17	3	10
29·0	10, 22	52·5	34·9	17·6	29·0	1, 31	6·0	27	81·0	39·5	3·76	13	4	11
27·0	10	54·6	39·5	15·1	33·0	31	3·0	12	. . .	. . .	4·46	22	3	6
31·0	22	56·6	40·5	16·1	26·0	31	8·5	13	. . .	. . .	3·11	16	11	14
26·0	10	59·0	37·4	21·6	35·0	5, 31	10·0	12	. . .	. . .	2·93	13	8	12
30·0	10	49·9	39·4	10·5	24·0	31	6·0	20	. . .	. . .	. . .	. . .	4	11
19·2	20	52·9	34·7	17·2	31·5	31	2·0	8	81·9	38·3	5·15	16	5	9
28·0	4, 20	50·6	37·3	19·3	36·0	31	4·0	12, 13	. . .	. . .	4·30	20	4	9
25·0	25	52·9	34·5	18·4	30·0	31	5·0	28	. . .	. . .	5·22	13	4	8
31·0	11	56·5	41·0	15·5	32·5	25	2·5	28	. . .	. . .	3·82	16	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
32·0	4	57·9	42·6	15·3	31·5	5	4·0	12	76·3	42·4	3·19	17	6	13
34·9	30	55·5	42·1	13·4	27·2	5	6·4	24	75·6	39·7	2·04	16	8	7
30·3	10	57·3	40·7	16·6	27·0	19	8·7	12	75·4	41·6	4·75	11	3	11
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
34·0	21	54·2	40·7	13·5	30·0	31	7·0	6	75·6	38·7	3·17	21	5	2
29·0	10	58·3	41·4	16·9	34·0	31	8·0	20	76·2	48·0	5·16	18	8	16
31·0	21	57·1	39·6	17·5	37·0	31	7·0	13	85·1	40·0	4·70	10	2	5
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
28·0	4	57·8	39·4	18·4	36·0	5	5·0	6	80·0	41·2	3·62	14	5	14
29·0	22, 31	56·0	37·7	18·3	40·5	31	6·0	20	. . .	. . .	3·49	14	5	12
26·0	10	56·2	36·0	20·2	37·0	25	4·0	13	81·0	40·6	5·48	16	4	5
31·0	15	52·9	37·4	14·5	28·0	5, 26	6·0	7	78·0	40·0	3·51	16	2	24
29·5	22	57·3	38·3	18·8	31·5	31	10·0	23	75·1	41·3	3·14	12	6	13
25·0	10	56·2	36·6	19·6	39·0	31	6·0	21	85·4	43·4	3·99	16	3	8
29·9	15	56·6	38·9	17·7	31·7	31	8·1	12, 23	77·6	48·1	3·22	17	7	15
28·0	22	55·2	35·9	19·3	30·0	31	7·0	30	. . .	. . .	4·75	13	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
29·5	22	52·5	34·0	18·5	36·0	31	3·0	21	. . .	. . .	7·66	18	4	11
20·3	10	54·4	37·1	17·3	36·8	25	7·3	16	83·9	42·8	3·16	16	4	6
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
28·0	10	57·4	41·0	16·4	30·0	31	4·0	24	80·0	43·0	2·82	9	9	15
29·0	31	56·0	40·0	16·0	32·0	31	7·0	13, 21	84·0	44·0	2·77	10	14	5
26·0	11	56·3	36·6	19·7	36·0	31	10·0	6	78·8	41·0	2·75	12	. . .	. . .
29·0	4, 31	56·9	37·6	19·3	35·0	5	9·0	12	. . .	. . .	3·98	14	8	9
34·8	22	58·9	44·4	14·5	24·8	31	8·4	24	71·8	41·0	3·23	16	9	10
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
21·0	11	51·0	33·6	17·4	36·0	31	2·0	2	80·0	36·5	4·60	13	7	4
30·0	11	53·2	38·4	14·8	26·0	25, 31	7·0	6	. . .	. . .	4·83	12	7	13
31·5	15	54·6	40·0	14·6	29·5	25	4·0	12	76·7	44·0	. . .	13	4	11
26·0	4	54·2	35·0	19·2	41·0	31	7·0	26	91·1	40·8	5·47	18	10	3
26·0	22	45·7	34·0	11·7	21·0	10	3·0	14	87·0	37·3	9·18	17	4	9
27·0	3	49·0	33·7	15·3	32·0	31	4·0	14	87·0	37·9	4·05	13	3	11
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
24·0	22	51·4	36·6	14·8	. . .	. . .	. . .	. . .	82·2	41·2	6·69	27	0	3
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
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24·0	10, 11	52·3	35·8	16·5	42·0	31	2·0	20	85·4	39·0	4·22	23	4	6
22·0	11	49·7	33·3	16·4	39·0	31	5·0	9, 21	. . .	. . .	3·97	14	2	10
23·0	11	49·0	34·7	14·3	24·0	5, 25	4·0	9, 21	. . .	. . .	3·92	15	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
30·0	4	58·5	40·5	18·0	28·0	25	9·0	23, 26	75·9	40·7	2·24	16	13	9

FOR OCTOBER, 1888.

Number of Days.			Wind.			Observers.
			Prevailing Direction.			
Clear.	Fair.	Cloudy.	7 A. M.	2 P. M.	9 P. M.	
4	7	20	NW	NW	NW	Oscar D. Stewart, Sgt. Sig. Corps.
10	11	10	"	"	"	Smith Curtis.
. . .	. . .	. . .	W	SW	NW	Rev. A. Thos. G. Apple.
12	3	16	NW	NW	NW	C. M. Dechant, C.E.
. . .	. . .	. . .	. . .	. . .	. . .	Prof. J. H. Rohrbach.
. . .	. . .	. . .	. . .	. . .	. . .	Dr. Charles B. Dudley.
7	11	13	W	W	W	Prof. J. A. Stewart.
4	3	24	NW	NW	NW	Charles Beecher.
6	13	12	NW	NW	NW	J. L. Heacock.
. . .	. . .	. . .	. . .	. . .	. . .	J. E. Forsythe.
. . .	. . .	. . .	. . .	. . .	. . .	E. C. Lorentz.
3	10	18	W	W	W	T. B. Lloyd
4	11	16	W	W	W	Prof. Wm. Frear.
3	6	20	NW	NW	NW	Geo. H. Dunkle.
11	14	6	NW	NW	NW	Jesse C. Green, D.D.S.
8	12	11	W	W	W	W. T. Gordon.
4	11	16	SW	SW	SW	Rev. W. W. Deatrick, A.M.
5	9	17	E	W	E	C. M. Thomas, B.S.
4	9	18	W	W	W	Nathan Moore.
4	8	19	W	W	W	Prof. John A. Robb.
. . .	. . .	. . .	. . .	. . .	. . .	Robert M. Graham.
. . .	. . .	. . .	. . .	. . .	. . .	Prof. J. H. Montgomery.
6	13	12	W	W	W	J. E. Pague.
8	7	16	NW	NW	NW	Frank Ridgway, Sgt. Sig. Corps.
3	11	17	NW	NW	NW	Prof. Susan J. Cunningham.
. . .	. . .	. . .	"	"	"	
5	2	24	NW	NW	NW	Peter Wood, Sgt. Sig. Corps.
8	16	7	NW	SW	NW	Wm. Hunt.
2	5	24	W	W	W	Robert L. Haslet.
. . .	. . .	. . .	. . .	. . .	. . .	P. C. Richardson.
5	14	12	NW	NW	NW	Thomas F. Sloan.
5	12	14	W	W	W	Prof. W. J. Swigart.
4	5	22	SW	SW	SW	Prof. Albert E. Maltby.
9	24	5	E	E	NE	J. F. Baumeister.
6	13	12	W	W	W	A. M. Schmidt, A.B.
3	8	20	NW	NW	NW	Wm. T. Butz.
7	15	9	SW	SW	SW	George W. Hayes, C.E., Ph.G.
. . .	. . .	. . .	NW	NW	NW	H. D. Miller, M.D.
. . .	. . .	. . .	"	"	"	
4	11	16	SW	W	W	Armstrong & Brownell.
4	6	21	SW	SW	S	Prof S. H. Miller.
. . .	. . .	. . .	. . .	. . .	. . .	N. C. Miller, M.D.
9	15	7	NW	NW	NW	Charles Moore, D.D.S.
14	5	12	W	NW	NW	Lerch & Rice.
. . .	. . .	. . .	NW	W	W	G. R. Hanley.
8	9	14	W	W	W	Frank Mortimer.
9	10	12	NW	NW	NW	Luther M. Dey, Sgt. Sig. Corps.
. . .	. . .	. . .	"	"	"	
7	4	20	W	W	W	C. L. Peck.
7	13	11	NW	NW	NW	E. C. Wagner.
4	11	14	SW	SW	SW	J. M. Boyer.
10	3	18	NW	NW	NW	W. M. Schrock.
4	9	18	SW	SW	SW	E. S. Chase.
3	11	17	SW	SW	W	C. R. Claghorn.
. . .	. . .	. . .	. . .	. . .	. . .	A. H. Berlin.
0	3	28	N	N	N	H. D. Deming.
. . .	. . .	. . .	. . .	. . .	. . .	Prof. N. P. Kinsley.
. . .	. . .	. . .	. . .	. . .	. . .	Jacob Gayman.
. . .	. . .	. . .	"	"	"	
4	6	21	SW	SW	SW	Wm. Loveland.
9	10	12	NW	NW	NW	Theodore Day.
. . .	. . .	. . .	. . .	. . .	. . .	John Torrey.
. . .	. . .	. . .	. . .	. . .	. . .	H. S. Brunot.
13	9	9	NW	NW	NW	Mrs. L. H. Grenewald.

T. F. Townsend, *Sergeant Signal Corps, Assistant.*

	Erie.	Greenville.	New Castle.	
	'45	'32	'27	
	'12	'08	'56	
	. .	'04	. .	
	'02	'17	. .	
	'09	. .	'27	
	'48	'07	. .	
	'10	'03	'52	
	. .	. .	. .	
	. .	. .	. .	
	. .	'47	. .	
	'78	'22	'19	
	'10	. .	'31	
	'14	. .	. .	
	. .	'08	. .	
	'01	'17	'72	
	'01	. .	. .	
	. .	1'10	. .	
	'55	'04	. .	
	'02	. .	'45	
	'04	'18	. .	
	'01	'14	. .	
	'08	'08	'33	
	'08	. .	. .	
	. .	'03	. .	
	'03	. .	'22	
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	'04	. .	'15	
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	. .	. .	. .	
	. .	. .	. .	
	3'17	3'26	3'99	3

PRECIPITATION FOR OCTOBER, 1888.

	Erie.	Greenville.	New Castle.	Beaver.	Meadville.	Columbus.	Tionesta.	Pittsburgh.	Clarion.	Uniontown.	Indiana.	Somerset.	Grampian Hills.	Emporium.	Phillipsburg.	Hollidaysburg.	Smethport.	Altoona.	Charlesville.	State College.	Huntingdon.	McConnellsburg.	Lock Haven.	New Bloomfield.	Carlisle.	Wellsboro.	York.	Harrisburg.	Wysox.	Eagles Mere.	Bernice.	Catawissa.	Shamokin.	Girardville.	Lebanon.	Lancaster.	Reading.	Kutztown.	Scranton.
1	.45	.38	.27	.60	.85	.44	. .	.60	1.37	.47	1.20	.57	.30	.69	.23	.44	.40	.09	.15	.32	.11	.09	1.10	.23	.35	.30	.04	.10	.28	1.41	.73	.41	.25	.58	.20	.17	.12	.27	.60
2	.12	.08	.56	.02	.20	.22	. .	.10	.02	.55	.20	.15	.81	.03	.75	.14	.20	.47	.16	.07	.20	.08	.07	.10	.04	.12	. .	.05	. .	.02	.20	.16	.13	.02	.05	. .	. .	. .	.25
3	. .	.04	. .	. .	. .	.01	. .	. .	. .	. .	. .	. .	. .	. .	.03	. .	. .	.05	. .	. .	. .	. .	. .	. .	. .	.04	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.03
4	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
5	.02	.17	. .	. .	.22	.15	. .	. .	. .	. .	. .	. .	. .	. .	.01	. .	.40	. .	.05	. .	. .	. .	. .	. .	.08	. .	. .	.24	1.90	. .	. .	. .	.42	. .	. .	. .	.20	.10
6	.09	. .	.27	.40	.22	.11	1.00	.51	.55	.31	.45	.48	.46	.70	.27	.13	.63	.22	.43	.35	.40	.41	.65	.44	.01	2.98	.06	.24	.56	. .	.49	.65	.48	.60	.34	.34	.77	.36	.12
7	.42	.07	. .	.20	. .	.32	.20	.23	.05	.49	.22	.14	.20		.05	.06	.20	.07	. .	.03	.06	. .	.07	. .	.03	.05	. .	. .	.06	.44	.02	.03	. .	. .	. .	. .	. .	. .	.09
8	.10	.03	.52	.05	.20	.04	. .	.06	. .	.11	. .	.15	.15	.04	.07	.06	. .	.03	.05	. .	. .	. .	. .	.02	. .	.10	.01	.02	. .	.04	.14	.03	.05	.05	.04	. .	.04	.10	.04
9	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
10	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
11	. .	.47	. .	.45	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.09	. .	. .	. .	. .	.60	.10	. .	. .	. .	. .	.01	.02	.07	. .	. .	. .	. .	.28	.02	. .	. .	. .	. .
12	.78	.22	.19	. .	.80	1.05	.70	.40	.82	.55	.73	.59	.24	.42	.69	.54	.45	.39	.50	.54	. .	.68	.63	1.00	.73	.40	.31	.16	.01	.90	.18	.27	.10	. .	.16	.24	.26	.17	.07
13	.10	. .	.31	. .	.20	.10	.30	.13	.32	.10	.30	.59	.20	.19	.05	. .	.12	.07	. .	.27	.10	.05	.10	.05	.06	.24	.02	.08	.08	1.02	.34	.08	.10	.24	.12	.03	.02	. .	. .
14	. .	. .	. .	. .	.05	.06	. .	.04	.06	.02	.05	.03	.06	.04	.10	. .	.80	. .	. .	. .	.08	.08	. .	. .	.02	.04	.02	.02	. .	. .	.09	. .	.02	. .	.01	. .	.16	.05	. .
15	. .	.08	. .	.20	.05	. .	. .	. .	. .	.09	. .	.27	. .	. .	.08	. .	.14	.01	. .	. .	. .	. .	. .	. .	.01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
16	.01	.17	.72	.15	.05	.15	.20	.11	.15	. .	.41	.07	.34	.17	.10	.55	.16	.07	.10	.64	. .	. .	.15	.04	. .	.20	.01	. .	.47	.25	.20	.43	. .	.44	.01	.05	. .	.05	.13
17	.01	. .	. .	.05	. .	.10	.50	.28	.15	.67	.32	.52	. .	.16	.61	. .	.16	.36	.10	. .	.56	.04	. .	.20	.13	.16	.02	.18	. .	.65	.52	.13	. .	. .	.17	.15	.11	.10	.3
18	. .	1.10	. .	. .	.10	.08	. .	. .	. .	.11	. .	. .	.10	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
19	.55	.04	. .	.60	.65	.70	.70	.33	.61	.41	.50	.69	.73	.89	.17	.73	.64	.12	. .	.71	.59	.47	1.50	.45	.05	.64	.32	.39	.30	.57	.44	.64	.72	.59	.32	.48	.42	.47	.31
20	.02	. .	.45	. .	.32	.15	. .	.01	.10	.43	.02	.01	. .	.03	.58	.04	.16	.42	. .	. .	. .	. .	. .	. .	.40	.25	.03	.01	. .	. .	. .	. .	. .	.03	. .	.44	. .	. .	. .
21	.04	.18	. .	. .	.17	.03	.20	. .	.20	. .	. .	. .	. .	. .	.03	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
22	.01	.14	. .	. .	. .	.05	. .	.04	. .	.15	.02	.07	. .	. .	. .	.09	.80	. .	.04	. .	. .	. .	.06	. .	. .	.05	. .	. .	.05	.01	. .	.10	. .	. .	. .	. .	. .	. .
23	.08	.02	.33	.10	.20	.08	.70	.18	.24	.12	.30	.40	.32	.17	.19	.31	. .	.16	.16	.11	.21	.31	.17	.15	.14	.04	.15	.13	.30	.34	. .	.18	.07	.51	.21	.26	.10	.10	.19
24	.08	. .	. .	. .	.15	.18	. .	.12	.11	.32	.02	.27	.21	.20	.18	.04	. .	.12	. .	.13	.09	.09	.18	.10	.17	.20	.10	.16	. .	. .	. .	.11	.28	. .	.20	.22	.33	.07	.30
25	. .	.03	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
26	.03	. .	.22	.10	. .	.02	.20	.10	. .	.15	.04	.17	. .	. .	.01	.25	1.00	. .	.39	.03	.02	.29	. .	.10	.02	.05	.17	.06	.06	1.03	. .	.07	. .	.27	.03	.08	. .	. .	. .
27	. .	. .	. .	. .	.10	.10	. .	.03	.25	. .	. .	. .	.18	.08	.07	.02	.20	.13	.24	.15	.20	.59	.21	.78	.75	.05	.83	.26	. .	. .	.29	.02	.22	.77	.96	.91	.79	1.05	.24
28	.04	. .	.15	.10	.05	.01	. .	.19	.15	.11	.70	.30	.18	.28	.18	.16	.60	.07	.15	.21	.27	.34	.33	.32	.27	.56	.14	.16	.54	. .	.41	.51	.33	. .	.35	.21	.21	.57	.41
29	.08	. .	. .	. .	. .	.07	. .	. .	. .	. .	. .	. .	. .	.01	. .	. .	.60	.01	. .	. .	. .	. .	. .	. .	. .	.10	. .	. .	.08	. .	. .	. .	. .	. .	. .	. .	. .	. .	.13
30	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.05	.01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
31	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
	3.17	3.16	3.99	3.02	4.58	4.22	4.70	3.46	5.15	5.16	5.48	5.47	4.50	4.15	4.46	3.85	7.66	2.92	2.52	3.76	3.49	3.62	5.22	3.98	3.19	6.69	2.34	2.04	3.24	9.18	4.05	3.82	2.75	4.83	3.22	3.14	3.77	3.62	3.31

PRECIPITATION FOR OCTOBER, 1888.

Huntingdon.	McConnelsburg.	Lock Haven.	New Bloomfield.	Carlisle.	Wellsboro.	York.	Harrisburg.	Wysox.	Eagles Mere.	Bernice.	Catawissa.	Shamokin.	Girardville.	Lebanon.	Lancaster.	Reading.	Kutztown.	Scranton.	Pottstown.	West Chester.	Coatesville.	Dyberry.	Honesdale.
.11	.09	1.10	.23	.35	.30	.04	.10	.28	1.41	.73	.41	.25	.58	.20	.17	.12	.27	.60	.12	.16	.12	.49	.76
.20	.08	.07	.10	.04	.12	. .	.05	. .	.62	.20	.16	.13	.03	.05	. .	. .	. .	.25	. .	. .	. .	.35	. .
. .	. .	. .	. .	. .	.04	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.03	. .	. .	. .	. .	.05
. .	. .	. .	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
. .	. .	. .	. .	. .	.08	. .	. .	.24	1.90	. .	. .	. .	.42	. .	. .	. .	.20	.10	. .	. .	. .	. .	. .
.40	.41	.65	.44	.01	2.98	.06	.24	.56	. .	.49	.65	.48	.60	.34	.34	.77	.36	.12	.13	.20	.25	.25	.42
.06	. .	.07	. .	.03	.05	. .	. .	.06	.44	.08	.03	. .	. .	. .	. .	. .	. .	.09	. .	.05	. .	.30	. .
. .	. .	. .	.02	. .	.10	.01	.02	. .	.04	.14	.03	.05	.05	.04	. .	.04	.10	.04	. .	.02	. .	. .	.02
. .	. .	. .	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.08	. .	. .	. .
. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
.60	.10	. .	. .	. .	. .	.01	.02	.07	. .	. .	. .	. .	.28	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .
. .	.68	.63	1.00	.73	.40	.31	.16	.01	.90	.18	.27	.10	. .	.16	.24	.26	.17	.07	.22	.30	.32	.15	.16
.10	.05	.10	.05	.06	.24	.02	.08	.08	1.02	.34	.08	.10	.24	.12	.03	.02	. .	. .	. .	.04	.15	.05	. .
.08	.08	. .	. .	.02	.04	.02	.02	. .	. .	.09	. .	.02	. .	.01	. .	.16	.05	. .	. .	. .	. .	.03	.06
. .	. .	. .	. .	.01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
. .	. .	.15	.04	. .	.20	.01	. .	.47	.25	.20	.43	. .	.44	.01	.05	. .	.05	.13	. .	.03	.02	.16	.29
.56	.04	. .	.20	.13	.16	.02	.18	. .	.65	.52	.13	. .	. .	.17	.15	.11	.16	.3	.35	.08	.11	.20	.14
. .	. .	. .	. .	.01	. .	. .	. .	.14	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
.59	.47	1.50	.45	.05	.64	.32	.39	.30	.57	.44	.64	.72	.59	.32	.48	.42	.47	.31	.35	.16	.17	.55	.59
. .	. .	. .	. .	.40	.25	.03	.01	. .	. .	. .	. .	. .	. .	.03	. .	.44	. .	. .	. .	.17	.07	.03	.02
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.21	.31	.17	.15	.14	.04	.15	.13	.30	.34	. .	.18	.07	.51	.21	.26	.10	.10	.19	.20	.46	.35	. .	.20
.09	.09	.18	.10	.17	.20	.10	.16	.	. .	. .	.11	.28	. .	.20	.22	.33	.07	.30	.30	.33	.27	.28	.11
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.20	.59	.21	.78	.75	.05	.83	.26	. .	. .	.29	.02	.22	.77	.96	.91	.79	1.05	.24	.90	.86	.88	.59	.61
.27	.34	.33	.32	.27	.56	.14	.16	.54	. .	.41	.51	.33	. .	.35	.21	.21	.57	.41	.25	.20	.17	.54	.42
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.49	3.62	5.22	3.98	3.19	6.69	2.24	2.04	3.24	9.18	4.05	3.82	2.75	4.83	3.22	3.14	3.77	3.62	3.31	2.82	3.11	2.93	3.97	3.92

| | | |

25th, 31st; Bernice, 9th, 10th, 11th, 15th, 18th, 20th, 25th, 26th; Wellsboro, 11th, 15th, 20th, 21st, 22d, 25th; Columbus, 3d, 9th, 10th, 11th, 15th, 19th, 21st, 22d, 25th, 30th, 31st; Dyberry, 1st, 3d, 4th, 9th, 10th, 11th, 15th, 16th, 18th, 19th, 20th, 21st, 22d, 25th, 26th, 30th, 31st; York, 4th, 10th, 11th, 13th, 15th, 18th, 22d, 25th.

Coronæ.—Reading, 19th; Rimersburg, 18th; Lancaster, 24th; Eagles Mere, 18th, 20th.

Solar Halos.—Wellsboro, 10th, 15th, 18th; Eagles Mere, 11th, 18th, 22d, 26th; Dyberry, 15th, 18th, 26th, 29th.

Lunar Halos.—Reading, 18th; Kutztown, 18th; Quakertown, 18th, 22d; West Chester, 18th; Clarion, 21st; Lock Haven, 18th; Carlisle, 18th, 24th; Indiana, 21st; Lancaster, 18th, 24th, 25th; Lebanon, 18th, 26th; Shamokin, 18th; Philadelphia, 18th; Eagles Mere, 18th; Wellsboro, 18th; Dyberry, 11th, 26th; York, 18th.

The policy of the Chief Signal Officer with regard to display stations is very liberal, and where the weather signals will prove of value to the public, dispatches will be sent to selected points that are properly equipped for display.

A few sets of weather, temperature, and cold wave signal flags will be furnished by the Pennsylvania State Weather Service to those who will attend to their display. Application for the establishment of the stations and for flags should be made at once.

In order that there may be no unnecessary delay in the issue of the Monthly Weather Review, observers are requested to send in their reports as early and as complete as practicable.

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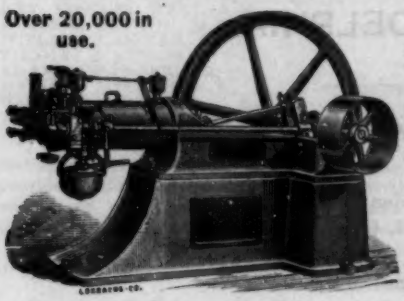

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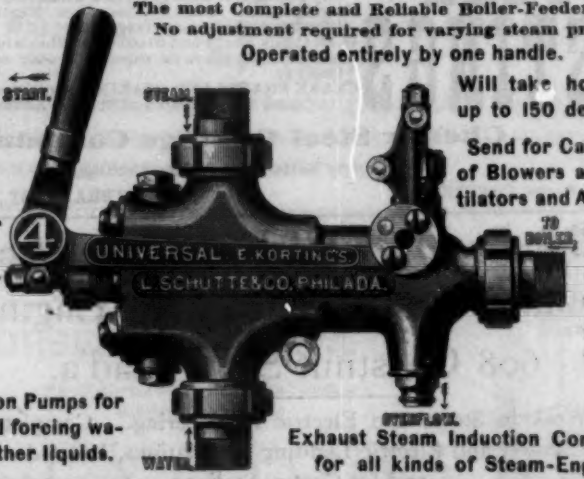

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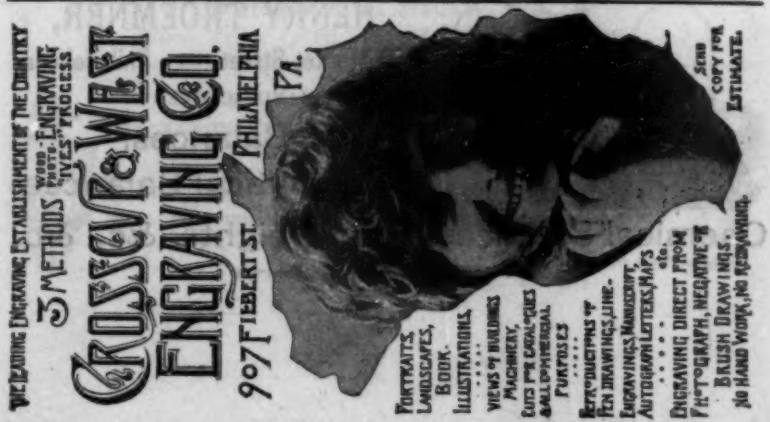
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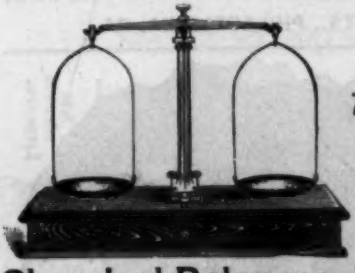

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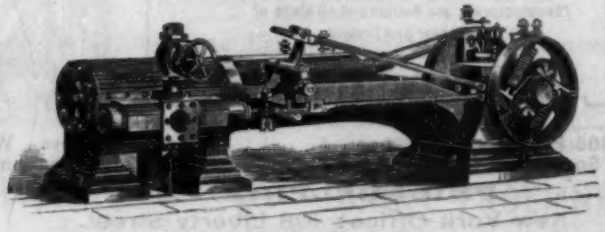
TRENTON  ENGINE

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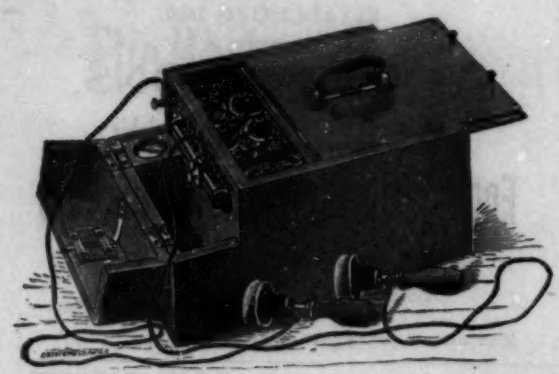

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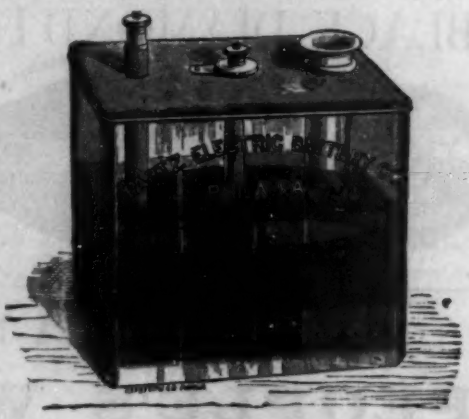

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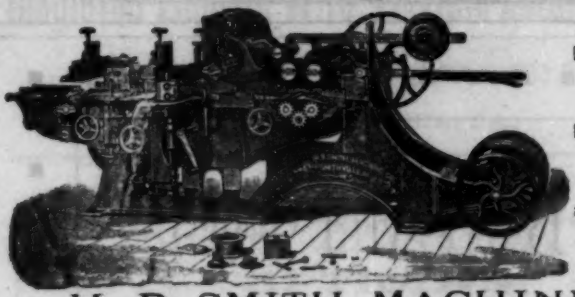

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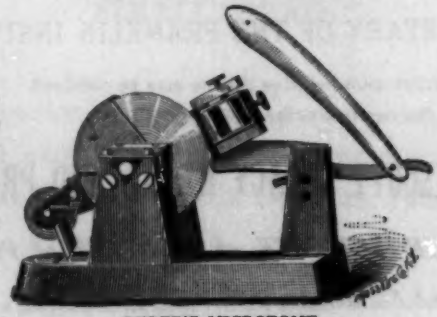

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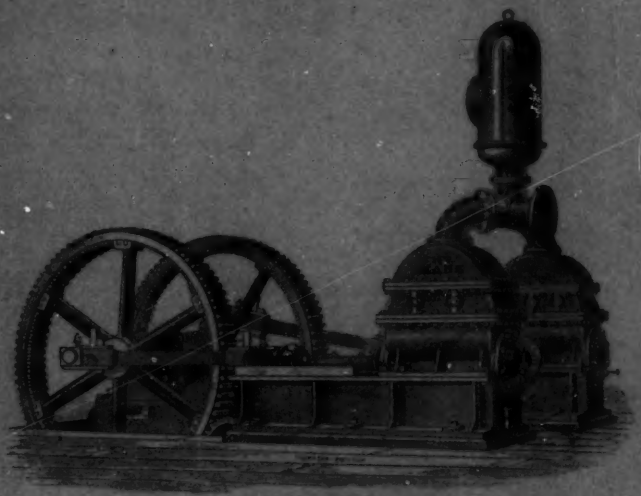

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